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INDIAN AGRICULTURAL
RESEARCH INSTITUTE, NEW DELHI

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GIP NLK—H-3 I.A.R.I.—10-5 55—15,000

Occasional Papers

OF THE

CALIFORNIA
ACADEMY OF SCIENCES

XVII

PRINTED FROM THE
JOHN W. HENDRIE PUBLICATION ENDOWMENT

24938



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SAN FRANCISCO
PUBLISHED BY THE ACADEMY
FEBRUARY 14, 1931

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LOG OF THE SCHOONER “ACADEMY”

On a Voyage of Scientific Research
to the Galapagos Islands
1905-1906

BY
JOSEPH R. SLEVIN
Curator, Department of Herpetology

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LOG OF THE SCHOONER "ACADEMY"**ON A VOYAGE OF SCIENTIFIC RESEARCH TO THE
GALAPAGOS ISLANDS
1905-1906**

BY

JOSEPH R. SLEVIN*Curator, Department of Herpetology***INTRODUCTION**

For some time previous to the year 1905 the late Mr. Leverett Mills Loomis, then Director of the Museum of the California Academy of Sciences, had in mind the sending of an expedition to the Galapagos Islands, an archipelago situated on the equator 650 miles off the coast of Ecuador, and made famous to every naturalist by Charles Darwin, whose account of the voyage of H. M. S. *Beagle* has become a classic amongst students of nature.

The Galapagos have been visited several times since by naturalists but their stops were all too short and the means at their disposal for carrying on their investigations very limited. It was the idea of Mr. Loomis to send out an expedition that would have ample time to make an exhaustive survey, most extensive collections, and, most of all, to make a thorough study of the status of the gigantic land tortoises and secure specimens of the various species before it proved too late. The result was that an expedition was organized and sent out, remaining in the field for 17 months and one day, and bringing back the largest and finest collections ever made on the islands. The study of the land tortoises, of which 266 specimens were collected, resulted in straightening out many difficult problems, and, with the exception of Charles Island, showed them to be still living on all of the islands in the archipelago from which they were formally known and that they even existed on islands they were never before known to be on.

ORGANIZATION

To overcome one of the great handicaps of some of the others who had visited the islands, a vessel was purchased for making the voyage, thus avoiding the various difficulties encountered by others when depending on commercial vessels or vessels of war, and enabling the Party to proceed when and where it chose.

Of the available vessels about San Francisco at the time, the U. S. S. *Earnest*, then being offered for sale by the Government, seemed to be the most suitable, and it was accordingly secured by the Academy. The *Earnest* was built at Baltimore, Maryland, in 1875, and was a two-masted composite schooner of 80 tons displacement, 89 feet in length over all, 23 feet beam, had a draft of 7 feet 3 inches, carried two topmasts and, up to the time she was stricken from the register, was employed by the United States Coast and Geodetic Survey. The schooner was brought from the Mare Island Navy Yard to a local shipyard, where she was overhauled and had extra tanks put in so as to ensure an ample water supply. She was re-christened *Academy*, and June 25, 1905, saw her alongside the Mission Street bulkhead, San Francisco, ready to load supplies and equipment. She was loaded with sufficient food for about 20 months and carried a six months' supply of water.

The personnel of the party consisted of 11 members, as follows:

R. H. Beck	Chief of Party and Master of the vessel
W. H. Ochsner	Geologist
F. X. Williams	Entomologist
E. W. Gifford	Ornithologist
J. S. Hunter	Ornithologist and Mammalogist
A. Stewart	Botanist
J. R. Slevin	Herpetologist
E. S. King	Assistant Herpetologist
F. T. Nelson	Mate
J. J. Parker	Navigator
J. W. White	Cook

The expedition left San Francisco on June 28, 1905, and did not return until the night of November 29, 1906. Five

months were consumed in making the journey to and from the Galapagos and a year was spent in the archipelago itself.

The following account of the cruise of the *Academy* is taken from the official log-book of the vessel and from the diaries of the author and of Mr. F. X. Williams, who very kindly permitted his to be used.

With the exception of the two pictures of the schooner, loaned by Mr. Williams, the plates are from original photographs by Mr. R. H. Beck, who very kindly loaned them to the author, and it is with his permission that they are published.

For the convenience of those making use of the publications dealing with the results of the expedition, the following lists are given to show the dates the various islands were visited, either from the schooner or on side trips made in the small boats.

LOCALITIES VISITED EN ROUTE TO THE GALAPAGOS

1905		
JULY	3-5	Ensenada, Lower California, Mexico
	11	San Martin Island
	13	San Geronimo Island
	14-17	San Benito Island (west)
	15	" " " (east)
	15	" " " (middle)
	18	Cerros Island
	19	Natividad Island
	26	San Benedicto Island
	27-28	Socorro Island
	27	" " (Oneal Rock)
AUG.	10	Clipperton Island
SEPT.	3-13	Cocos Island

LOCALITIES VISITED IN THE GALAPAGOS

1905		1906		
SEPT.	24-30	JAN.	31	Hood Island
OCT.	1-2	FEB.	1-14	" "
		JUNE	23-30	" "
		JULY	1-2	" "
SEPT.	27	FEB.	3	Gardner Island (near Hood)
	30	JUNE	27	" " " "

1905		1906		
OCT.	3			Gardner Island (near Charles)
OCT.	3	FEB.	26	Champion Island
OCT.	3-13	FEB.	25-28	Charles Island
		MARCH	1-2	" "
		MAY	14-17	" "
		MAY	23-31	" "
		JUNE	1-4	" "
OCT.	14-18	JAN.	24-30	Chatham Island
		FEB.	8	" "
		FEB.	21-24	" "
		JULY	3-8	" "
		SEPT.	7-10	" "
OCT.	20-24	JULY	9-10	Barrington Island
OCT.	24-28	JAN.	11-22	Indefatigable Island
NOV.	5-30	JULY	11-25	" "
OCT.	30			Brattle Island
OCT.	31	MARCH	4-10	Albemarle Island (Vilamal)
NOV.	1-3	APRIL	30	" "
		MAY	1-3	" "
		AUG.	20-31	" "
		SEPT.	1-5	" "
		MARCH	11-15	" " (south coast)
		APRIL	24-26	" "
		MARCH	17-21	" " (Iguana Cove)
		MARCH	22-31	" " (T. gus Cove)
		APRIL	1-8	" "
		APRIL	17-20	" "
		APRIL	10-16	" " (Banks Bay)
		AUG.	9-12	" " (Cowley Mountain)
NOV.	20-22	JULY	25-26	South Seymour Island
NOV.	29			" " "
NOV.	23	JULY	25	Daphne Island
DEC.	1-17	AUG.	14-15	Duncan Island
DEC.	18-20			Jervis Island

1905		1906	
DEC.	19-31	JAN.	1-4 James Island
		JULY	28-31 " "
		AUG.	1-9 " "
		FEB.	25 Onslow Island
		MARCH	22 Narborough Island
		APRIL	2-5 " "
		APRIL	18-19 " "
		MAY	14 Enderby Island
		JULY	24 Eden Island
		JULY	27 Bartholomew Island
		JULY	30 " "
		AUG.	13 Cowley Island
		SEPT.	14-15 Tower Island
		SEPT.	17-18 Bindloe Island
		SEPT.	18-23 Abingdon Island
		SEPT.	24 Wenman Island
		SEPT.	25 Culpepper Island

LOG OF THE SCHOONER "ACADEMY"

1905

June 28: 10:00 A. M. tug *Relief* made fast alongside and at 10:30 hauled out from Mission Street bulkhead, heading for the Golden Gate. Set all lower sails after crossing the bar and at 12:45 P. M. let go the tug. Took departure from the San Francisco lightship, bearing NW. by compass, distant two miles. Weather slightly hazy with moderate westerly breeze. Set course for Ensenada, Mexico. Most of the party never having been to sea before succumbed rather early. Gifford and myself standing watch and watch at the wheel, the mate and navigator taking the deck. At sundown a four-masted bark under all plain sail passed to windward of us.

June 29: Moderate westerly breeze. Most of the party still seasick. Vessel making about five knots. During the

1905

second dog watch the main peak-halyard block unshipped, so the mainsail was lowered and made fast for the night. Lat. $34^{\circ} 56' N.$, Long. $122^{\circ} 42' W.$ at meridian.

June 30: Opened with strong westerly winds and overcast sky. At 1:00 P. M. set the mainsail, the seasick members turning out to lend a hand at the halyards. 4:00 P. M. winged out the foresail to starboard and ran the schooner wing and wing. Wind increasing towards evening, we lowered the mainsail and made it fast for the night. The main deck leaks considerably, making it rather uncomfortable below. Nelson and myself spending our watch below overhauling stores to prevent damage by water and plugging up leaks with empty sacks. Lat. $32^{\circ} 39' N.$, Long. $120^{\circ} 26' W.$ at meridian.

July 1: Opened with fresh westerly wind, the wind falling light at 10:00 P. M. and hauling to the northward. Members of the party feeling better today and Williams appeared at the table. In the afternoon the vessel was almost becalmed and I went out in the skiff with Beck shooting petrels. We baited them with refuse from the galley and Beck shot about eleven. Saw numbers of shearwaters and Black-footed Albatrosses. Lat. $32^{\circ} 05' N.$, Long. $117^{\circ} 41' W.$ at meridian.

July 2: At 2:00 A. M. made the land to the northward of Todos Santos Bay and stood off shore till daybreak, when we shaped course for Ensenada. At 6:00 A. M. the vessel was almost becalmed. Saw several schools of bonitas and passed by large patches of kelp. Several whales about the vessel, one passing within a hundred feet or so of us. Later in the morning the breeze freshened and at 1:15 we made the Port of Ensenada, letting go anchor off the wharf in four fathoms. Made fast sails and cleared up decks. Four days and three hours from San Francisco. Received the Captain of the Port on board and were given pratique. The seasick party feeling much better now and all of us are enjoying the warm weather.

July 3: All hands ashore collecting. The Commandante permitted us to take firearms ashore so I visited the valley back of Ensenada, bringing back 30 lizards, 12 toads and a snake, the first specimens of some thousands taken on the expedition. In the evening all hands were busy on board

1905

taking care of their specimens. Nelson busy overhauling running rigging.

July 4: Dressed ship in honor of Independence Day. All hands ashore collecting, and enjoying the warm weather after the trip down.

July 5: Captain of the Port notified us this morning that the ship's papers had been altered and that we could clear the vessel and stop at some of the islands off the coast of Lower California. E. W. Nelson, of the U. S. Biological Survey, who is just finishing up an account of the bird fauna of Mexico, on which he has been working for the past 14 years, was a visitor on board and had supper with us. A young couple from San Diego came on board this afternoon and wanted Beck to go outside the three-mile limit and marry them. Beck was willing, but the uncertainty of the wind forbade this and we had to let them wait in Ensenada two weeks so that they could claim residence and be married ashore.

July 6: 4:00 A. M. weighed anchor and stood out of Todos Santos Bay. Wind very light and some fog. Wind died down later in the morning and we drifted back towards the anchorage. Vessel becalmed and making no headway by noon.

July 7. Opened with very light winds. Made short tacks back and forth across the bay. Sighted a whale, two Black-footed Albatrosses and some shearwaters. This morning went out in the skiff with Beck shooting birds. About 10:00 A. M., a light breeze coming up, the schooner was put on the port tack and we stood out of Todos Santos Bay, heading for the channel between Punta Banda and Todos Santos Island. Had Todos Santos Island abeam at noon. Sighted our first turtle this morning.

July 8: Becalmed. 1:00 P. M. we were three miles SW. of Punta Banda, which we passed yesterday at noon. Williams caught a sphinx moth sunning itself on the main boom. Went out in the skiff with Beck shooting birds. Lat. $31^{\circ} 21' 30''$ N., Long. $116^{\circ} 48'$ W. at meridian.

July 9: Opened with fair breeze. Weather hazy with smooth sea. Calmed down in the afternoon, vessel making about five knots. Two doves lit on board, ate some bread

1905

crumbs we offered them, and then flew off. Sighted two sharks, several Black-footed Albatrosses and many shearwaters in the wake of the schooner. Four jaegers and a tropic-bird seen. All hands keeping the Sabbath. Lat. $31^{\circ} 00' N.$, Long. $117^{\circ} 14' W.$ at meridian.

July 10: Becalmed. While Williams was on watch at six o'clock this morning, a large moth (*Erebus odora*) flew on board and was caught. Vessel about 30 miles off shore. Went out with Beck shooting birds. Got nine Black-footed Albatrosses, some shearwaters and petrels. Several sharks about the schooner as she lay becalmed. Lat. $30^{\circ} 42' N.$, Long. $117^{\circ} 03' W.$ at meridian.

July 11: Opened with light winds and weather slightly foggy. At 5:30 A. M. we sighted the mainland, and at 6:00 A. M. San Martin Island. The schooner was headed down the channel and had the island abeam at noon, when we tacked ship and stood in. On approaching the island, a small sailing vessel, probably some poacher, hastily hoisted anchor and headed southward. While making up to the island, sighted a steamer bound north. At 2:30 P. M. hove the schooner to and landed a shore party. We found the island to be quite barren and rough, with only scattered patches of brush and a considerable growth of low-growing cactus, the spines of which were so tough and sharp that they went through the sides of our shoes. Towards the south end of the island we saw a large colony of cormorants and a considerable number of sea lions. The ornithologists collected some wrens, ospreys, cormorants and a blue heron. I found a gopher snake and two species of lizards. The landing party was called off at 5:30 P. M. and we headed southward under a fair breeze, the vessel making about eight knots.

July 12: Opened with light winds and warm weather. Vessel making from one to three knots on course to San Benito Islands. Sighted some whales, several sharks and a dolphin. Lat. $30^{\circ} 24' N.$, Long. $116^{\circ} 03' W.$ at meridian.

July 13: Opened with light winds, increasing towards noon, when the vessel logged seven knots. Early this morning we passed through a fair sized school of whales. At 3:00 A. M. passed a steamer bound south. 4:30 A. M. sighted

1905

San Geronimo Island, and Beck, having decided to try to land, we shaped a course for the north end, arriving there at 7:30 A. M. Hove the vessel to and landed a shore party. Much kelp about the island, making it very difficult to get the skiff through to the landing place. Ornithologists collected some auklets, oyster-catchers, etc., while I secured two species of lizards. The shore party was called off at 11:30 and course again set for the San Benito Islands. Wind NW. and the vessel making about six knots. Lat. 29° 46' N., Long. 115° 48' W. at meridian.

July 14: Opened with fresh breeze and fine weather. Had the west San Benito abeam at midnight and hove the vessel to. At 4:30 A. M. set course for anchorage. Wind light during the morning. At 12:30 P. M. made up to the anchorage and dropped anchor in 14 fathoms. After lunch put all boats out and went ashore collecting. Landing party found the island very barren as regards vegetation. Abalones, land shells and lizards (*Uta stellata*) very abundant. Ravens and several species of small land birds fairly abundant.¹ All hands returned to the vessel for supper. Ornithologists busy skinning birds late into the evening.

July 15: All hands ashore collecting. Party pulled over to the Middle San Benito, a low, rocky, barren island, about three-fourths of a mile in length. Found a few insects and lizards. Island almost destitute of vegetation. Spent about an hour on the island and then pulled over to the East San Benito, about two miles from the schooner. Found a large sea lion rookery and caught two pups and skinned them. All hands went in swimming and found the water very cold. Left shore at 6:00 P. M. and pulled back to schooner.

July 16: All hands keeping Sabbath. Williams, King and Nelson tried their luck at fishing over the side and caught several fine fish. Had lunch at 3:00 P. M. and found the fresh fish a most welcome addition to our bill of fare.

July 17: Turned out early and, with Beck, Gifford, Williams and King, landed on West San Benito Island to dig for

¹ On a visit made by the writer on board the Mexican Patrol Boat *Tecate* in 1922, land birds had become very scarce, no doubt due to the introduction of house cats by various fish camps

1905

petrels. Got ten petrels and two eggs. Beck shot a raven and several other birds. Hunter, Ochsner and Nelson went hunting sea lions on East San Benito Island. They killed and skinned out a large bull, bringing the hide back to the vessel. Spent some hours helping to scrape fat off of it. The skin measured about nine feet in length. At 12:30 weighed anchor and got under way for Cerros Island. Fresh NW. wind and sky overcast. At 5:15 P. M. beat up to the anchorage in South Bay, letting go anchor in $9\frac{1}{2}$ fathoms of water. Made fast sails and cleared up decks. During the night the wind increased, blowing off the land with great force. At 9:00 P. M. veered chain to 40 fathoms.

July 18: Landed on a rocky beach at South Bay, finding a cross erected on a high point at the west end of it. The country about South Bay is cut up into deep gullies and traveling is somewhat of a problem. A heavy wind was blowing at the time and it was with difficulty we made our way inland along the ridges. A high cliff containing many fossils was located at the west end of the beach. On getting inland we found everything extremely dry and desolate and the bottoms of the dry washes swarming with grasshoppers. This part of the island was not found to be particularly productive, although we did not come back empty handed. I collected a few lizards and a worm-snake, the first taken on Cerros Island. Nelson and Parker sent down the fore-topmast, the fore-topsail and all the gear connected with same. The fore-topsail was found to be useless, as the schooner would not lay up to the wind with the sail set, the centerboard being out of commission. All hands returned on board at 6:00 o'clock for supper. Fine weather with fresh NW. winds.

July 19: All hands turned out at 4:30 A. M. Cook prepared morning coffee and at 5:30 we weighed anchor, setting sail for Natividad Island. At 10:00 o'clock we made up to the island and hove the schooner to off the SE. end. The landing party shoved off in the skiff, the schooner beating to windward of the landing place. On nearing the beach we were hailed by a Mexican armed with a Winchester rifle, who ordered one man ashore first, so Beck landed, giving the Mexican our permits for visiting the island. Beck then hailed

1905

the boat and we landed, hauling the skiff up beyond the high tide line. We found that a short time before our arrival some poachers had landed, held up the guard at the point of a gun and stole all the guano that had been sacked and made ready for transportation; hence this time the guard was taking precautions. We found Natividad a typical desert island with numbers of giant cacti scattered about. Ospreys and oystercatchers were quite common along the shores. Two species of lizards were abundant and many dead land shells were found scattered about in the sheltered gullies. The landing party was called off at 3:30 P. M., the schooner running down before the wind to pick us up. At 4:10 P. M. departure was taken for San Benedicto Island, Sail Rock bearing by compass NW. by N., distant $\frac{1}{2}$ mile. Weather clear with strong NW. wind.

July 20: Opened with clear weather and fine sailing breeze. Schooner sailing wing and wing making about six knots. All hands busy with their specimens and standing watches. At 4:00 A. M. passed a steamer heading northward. Lat. $25^{\circ} 57' N.$, Long. $114^{\circ} 13' W.$ at meridian.

July 21: Opened with fine sailing breeze and clear weather. Still have the schooner wing and wing and making about six knots. Rougher sea put some of the boys under cover. Passed the Tropic of Cancer early this morning. Weather turned very much warmer this afternoon and under clothing is being shed. A shark and many flyingfish sighted during the day. One flyingfish landed on board. Lat. $23^{\circ} 35' N.$, Long. $112^{\circ} 55' W.$ at meridian.

July 22: Opened with clear weather and light NW. breeze. Turning very much warmer. In the afternoon the breeze slackened considerably so that at 4:00 P. M. the schooner was making about one knot per hour. A large shark accompanied by some pilotfish followed the schooner most of the day. Went out this morning in the skiff with Beck shooting birds. White tried to harpoon a shark that came close under our bows but did not succeed, the harpoon bending when it struck. However, while trying his luck with a hook and line, he caught a fine dolphin. Williams caught some water striders while working with a dipnet off the martingale stay. One

1905

frigate-bird and one tropic-bird sighted this morning. Schooner was becalmed at nightfall. Lat. $22^{\circ} 24' N.$, Long. $112^{\circ} 14' W.$ at meridian.

July 23: Opened with calm. Went out this afternoon with Beck shooting birds. All hands busy with their specimens and preparing for the work ahead of us. At 11:00 P. M. wind hauled N.NE. and the schooner logged about six knots. Lat. $21^{\circ} 02' N.$, Long. $111^{\circ} 57' W.$ at meridian.

July 24: Opened with strong NE. winds and sea rising considerably. At 4:00 P. M. took in flying-jib and gaff-topsail. 6:30 P. M. put two reefs in the mainsail. Just as we finished reefing the mainsail a heavy squall accompanied by rain passed over us. Looking very black to the southward. Sea quite heavy during the night but commenced to go down towards morning. Lat. $19^{\circ} 26' N.$, Long. $111^{\circ} 53' W.$ by dead reckoning at meridian.

July 25: Weather clearing and wind going down. Considerable cross swell running. At 12:00 M. shook out two reefs in the mainsail and set full. Weather now calm and Beck went out in the skiff shooting birds. One wounded shearwater was grabbed by a shark before it could be reached with the skiff. At noon time the weather was very warm and the man at the wheel was complaining of the heat. Several frigate and tropic-birds in sight. Nelson put out a shark line astern and hauled in one about seven feet in length. White cut out the jaws to save and, on opening up the stomach, found a shearwater, the remains of a pasteboard box and an old pair of slippers which Gifford had thrown overboard. Late in the afternoon a large school of porpoises crossed our bow. Ornithologists busy skinning birds. Temperature in cabin 90° . Lat. $19^{\circ} 32' N.$, Long. $111^{\circ} 09' W.$ at meridian.

July 26: Opened with light and variable winds. At 4:30 A. M. sighted San Benedicto Island, the north end bearing SE. by E. by compass. Had light winds until noon, when we were within half a mile of the north end. At 12:30 P. M. the landing party shoved off in the skiff, the navigator, cook and three men bringing the vessel around to the southeast side of the island. Nelson did the same with the skiff after landing the shore party. Found an immense colony of frigate-

1905

birds nesting in the high grass on top of the island. Ornithologists collected shearwaters and eggs. Boobies plentiful about the island and also an abundance of large grasshoppers. Nelson stood off shore in the skiff, while the schooner beat to windward of the island. The boys on board the schooner caught several fine big fish, which we had for supper. At 7:30 P. M. the schooner ran down before the wind and picked up the landing party. We then shaped course for Socorro Island. Variable winds and fine weather.

July 27: Opened with fine weather and light unsteady winds. Sunrise found us about four miles off the north end of Socorro Island. At 7:30 A. M. we hove to off the north end of the island and sent the skiff ashore to get some turtles. We landed on a nice sand beach, securing three large green turtles which had hauled out to dry off. Found many turtle nests on the beach, some with dead turtles that had just hatched out of the eggs and no doubt were literally cooked to death before they could get out of the nests, as the sand was so hot it was impossible to walk on it with bare feet. My own got so burned that they grew many large blisters. All hands returned at 1:00 P. M. and we shaped course for Oneal Rock off the west side of the island, arriving there at 1:30. Hove the schooner to and sent a landing party ashore. They found a large colony of terns and many boobies, the latter having their nests decorated with dead sea horses. Nelson caught some fine fish while standing by with the skiff. Landing party returned on board at 4:30 P. M. and we shaped course for Braithwaite Bay, Socorro Island. Winds light and variable. Many sharks swimming about the vessel. At 7:30 P. M. we were in a dead calm off the west end of the island. At 8:00 P. M. a fine sailing breeze sprang up and we kept the schooner hove to. Cape Rule bore by compass NE., distant two and a half miles, and at midnight NE. by N., distant four miles.

July 28: At 4:30 A. M. made course for the anchorage, letting go anchor at 7:45 A. M. in 16 fathoms of water and rocky bottom. Weather very hot. Found a fair-sized bunch of sheep near the landing place and some were shot for fresh meat. King ran down four small lambs and brought them on

1905

board. Landing party found this locality to be quite fruitful and secured large collections of birds, lizards, insects, etc. Country back of the landing place is rough and covered with a dense growth of brush, which makes traveling slow and laborious. Just back of the landing place we saw a grave bearing the date 1897 and a tablet erected by the U. S. S. *Boston* noting her arrival there while in search of the lost brigantine *Tahiti*. All hands returned on board at 6:00 P. M., Ochsner and King bringing some live sheep for a fresh meat supply. Took the skiffs on board and weighed anchor, but the wind died out and the schooner started drifting toward shore. The anchor was dropped under foot to await a change of wind. Shortly afterwards a light breeze sprang up and, in hoisting the anchor, it fouled on the bottom and the chain parted just outside the hawse pipe, losing the anchor and ten fathoms of chain. The wind being off the land, we set sail for Clipperton Island, taking departure from the anchorage

July 20: Opened with fine sailing breeze from the north. Weather very warm. Ornithologists busy skinning birds. The young lambs King brought on board made so much noise that they disturbed the peace of the ship and were brained with a belaying pin and thrown overboard. Sighted a large school of porpoises this afternoon. Lat. $17^{\circ} 22' N.$, Long. $110^{\circ} 33' W.$ at meridian.

July 30: Opened with strong easterly winds. Rain squalls during the night and much lightning to the southward. Sea choppy. All hands keeping the Sabbath. Lat. $14^{\circ} 55' N.$, Long. $109^{\circ} 58' W.$ at meridian.

July 31: Opened clear with wind still strong from the east. Schooner making about six knots. Weather turned squally during the afternoon. Towards evening the wind hauled S.S.W. and at 11:00 P. M. we had squally weather and rain. Barometer acting very uncertain. At 1:30 A. M. we took in the flying-jib and gaff-topsail. Keeping a full watch on deck on account of uncertain weather. Lat. $13^{\circ} 44' N.$, Long. $109^{\circ} 14' W.$ at meridian.

August 1: Opened clear with strong easterly winds. At 8:00 A. M. set flying jib and gaff-topsail. At 10:00 A. M.

1905

we were struck by a heavy squall which carried away the martingale stay, the chain parting about a foot from the martingale. The flying-jib halyards were let go on the run and the flying-jib boom was fortunately saved. At noon the wind went down and we had a heavy swell from the S.S.W. The weather became warm and sultry. King skinned one of the turtles taken at Socorro Island, while I helped Nelson repair the martingale stay. Went out in the skiff this afternoon with Beck shooting birds. Several squalls in sight to leeward of us at 6:00 P. M. Lat. $13^{\circ} 26' N.$, Long. $108^{\circ} 55' W.$ at meridian.

August 2: Opened with unsteady westerly winds and rain squalls. Heavy swell from the southwest. King and I skinned another of the green turtles taken at Socorro. 11:00 P. M. the port main lift carried away but did no damage. Much thunder and lightning during the night. Lat. $12^{\circ} 03' N.$ Long. $109^{\circ} 16' W.$ by dead reckoning at meridian.

August 3: Opened with light variable winds and calms. Nelson and I repaired the main lift. Much rain during the day. This afternoon helped King skin another of the turtles taken on Socorro Island. Some of the boys took advantage of the rain water in the skiff on deck to wash clothes. Strong current setting us W.N.W. Lat. $10^{\circ} 45' N.$, Long. $109^{\circ} 13' W.$ at meridian.

August 4: Opened with light winds and calms. Several showers passed over us during the morning but weather cleared up somewhat towards noon. Current setting us W.N.W. magnetic, rate uncertain. Many terns, shearwaters, frigate-birds and boobies flying about the schooner. Beat back and forth during the day without sighting Clipperton Island. Cabin getting rather unbearable; stuffy, moldy and hot. Lat. $10^{\circ} 47' N.$, Long. $109^{\circ} 20' W.$ at meridian.

August 5: Opened with variable winds and calms. Heavy swell from the southward makes the schooner roll considerably. Went out in the skiff with Beck to shoot birds. Shooting was difficult on account of the heavy swell but two terns and nine boobies were secured. We sighted a turtle from the skiff, but before we could get to it the turtle went under. Cur-

1905

rent set us N. $\frac{1}{2}$ E. magnetic during the last 24 hours. Lat. $10^{\circ} 35' N.$, Long. $109^{\circ} 01' W.$ at meridian.

August 6: Opened with variable winds and squalls. At 3:30 P. M. Clipperton Rock was sighted from the fore cross-trees, bearing E. by S. Hauled the schooner on the wind and shaped course for the island. At 6:30 P. M. Clipperton Rock bore E. by N. $\frac{1}{2}$ N. by compass, distant six miles. Wind in the afternoon more steady and weather clearing. A big school of bonitas about the schooner, but we are too busy working the vessel to try to catch any. Just at supper time a heavy rain storm passed over us. At 6:00 P. M. took in the gaff-topsail and flying-jib. Considerable lightning during the evening.

August 7: Opened with heavy winds and rain storms. Schooner beating back and forth trying to make Clipperton. Great numbers of boobies, terns and shearwaters sighted. Cabin damp, moldy and uncomfortable. Lat. $10^{\circ} 36' N.$, Long. $109^{\circ} W.$ by dead reckoning at meridian.

August 8: Opened with heavy swell from the southward with wind gradually decreasing. This morning I helped Nelson put a new kringle in the mainsail head and reeve off a new topsail sheet. In the afternoon went out in the skiff with Beck shooting birds. Found our chronometer to be out of rate about 35 seconds per day, no doubt owing to the dampness and excessive heat in the cabin. Lat. $10^{\circ} 20' N.$, Long. $109^{\circ} W.$ at meridian.

August 9: Opened with a fair sailing breeze. At 8:00 A. M. we passed through the tail end of a heavy squall. Vessel beating against the wind, and at 4:00 P. M. we were within two miles of the island. At 4:30 we made up to the land and passed close to the wharf, where we could see two men waving at us and saw in the distance on the opposite side of the island the wreck of the British ship *Kinkora* wrecked there in 1894. She was laden with lumber bound for the United Kingdom when she ran ashore in a heavy squall. It being too late to land, we stood away on the port tack, and when a safe distance away hove the schooner to, keeping a light in sight which the men on shore had put on

1905

top of the rock for us. At 6:30 P. M. Clipperton Rock bore N., distant three miles.

August 10: Opened with clear weather and fair sailing breeze. When it became full daylight this morning we ran down before the wind and at 7:00 A. M. hove to off the wharf, sending the landing party ashore in two boats. The surf was quite heavy and we shipped plenty of water making the landing, as we had to go through three lines of breakers and enter a boat passage through the outer reef. Messrs. Larsen and Shultz, the two keepers on the island, were at the beach to help us land. They informed us that they had been on the island since December, 1904, as keepers for the Pacific Island Co., this company holding a concession to work the guano deposits. We gave them some clay pipes, magazines, papers taken on board the day we left San Francisco, a bottle of whiskey from the medicine chest, some soda, yeast, onions and potatoes, the latter two articles being most welcome, as they never had any fresh vegetables. We found Clipperton to be a real coral atoll without a sign of vegetation, with the exception of a lone cocoanut palm growing by the house of the keepers and bearing about 20 nuts. The coral ring itself averages about 300 yards across and is about eight to ten feet above high water. There is no outlet to the ocean and the water in the lagoon is quite salty and brackish. We were told that at one time several Japanese engaged in working the guano deposits died from drinking this water. We found the island to be infested with land crabs; they were to be found everywhere. It was necessary when collecting birds to be on the spot as soon as they hit the ground, as the land crabs would have them ruined in a few seconds. In the lagoon are several low coral islets, at the time of our visit, densely populated with nesting terns. The eggs were so close together that it was necessary to pick one's steps so as not to tread on them. Clipperton Rock, a large basaltic rock about 50 feet in height, situated on the SE. edge of the reef, was found to be the home of hundreds of little lizards (*Lygosoma arundeli*), the only species on the island. Tiger beetles and damsel flies were common about the lagoon. As it was unsafe to keep the vessel about the island owing to the squalls and sudden changes in

1905

the weather, the landing party gathered at the keepers' house early in the afternoon, prepared to say good-bye and stand by to hail the schooner. Larsen treated us to some wine and cake made out of tern eggs taken off the islets in the lagoon. It was not at all bad. The cake was pink instead of yellow, owing to the color of the yolks, and had rather a peculiar though not unpleasant taste. When we had all gathered together and finished our good-bye, we made for the landing place and hailed the schooner. At 2:00 P. M. all hands were on board, having for the second time successfully negotiated the surf. Taking departure from Clipperton Rock, bearing N. by compass, distant three miles, we set our course for Culpepper Island, the most northern of the Galapagos group. Wind light and unsteady, hauling towards the SE. Swell going down considerably.

August 11: Opened clear with fair sailing breeze from SE. by E. Had some tern eggs for breakfast, a rather novel dish, but enjoyed by all. An observation showed our chronometer to be running slow and 2 minutes and 16 seconds out of rate. The dampness in the cabin is making leather moldy and guns rusty. Ornithologists busy with the catch from Clipperton. Nelson started to make a mast for the ship's boat. Few birds in sight this afternoon, but porpoises are becoming more abundant as we are getting towards the south. Wind got very light to almost calm during the evening. Steering full and by. Lat. $9^{\circ} 31' N.$, Long. $108^{\circ} 48' W.$ at meridian.

August 12: Opened with fine SW. sailing breeze, but later in the morning the wind went down and the schooner was becalmed. Occasional rain squalls passed over us and the weather became quite warm and sultry. Nelson started making a sail for the ship's boat. The rest of us busy with our specimens and standing watches. Some of the watch below busy breaking out stores from the hold and stowing them in the galley store room. Fine moonlight during the night and some of the boys sleeping on deck. Lat. $9^{\circ} 13' N.$, Long. $108^{\circ} 39' W.$ at meridian.

August 13: Opened with fine, clear weather, changing to calm early in the morning. Schooner sailing wing and wing

1905

making E.S.E. A strong odor permeated the cabin, the cause of which could not be found, until I discovered in the pocket of my hunting coat a tern, which I had taken on Clipperton Island three days ago. Lat. $8^{\circ} 41' N.$, Long. $107^{\circ} 43' W.$ at meridian.

August 14: Opened with light airs and calms. Had the skiff out this morning and caught three turtles. A large dolphin was seen swimming about the schooner, but it would not strike at the bait offered. Hunter busy blowing tern eggs taken on Clipperton. This afternoon a large shark grabbed the line we had out for the dolphin and snapped it off at the belaying pin to which it was made fast. Schooner in a dead calm most of the day. From 8:00 P. M. August 13 to 3:00 P. M. August 14 the log registered but half a mile. The navigator discovered a leak in the centerboard casing, which caused us to pump out the bilge twice a day. We were pumping out about 17 buckets of water every 12 hours. We found out afterwards that this leak had ruined a number of cases of canned goods. This evening at 8:00 P. M. we observed a partial eclipse of the moon. Took advantage of the calm weather to tar down the head gear. Current setting us to the eastward about $1\frac{3}{4}$ knots per hour. Lat. $8^{\circ} 33' N.$, Long. $107^{\circ} 21' W.$ at meridian.

August 15: Opened with schooner becalmed. Early in the morning a light NW. wind sprang up, bringing with it a shower of rain. Nelson caught a bonita this morning with a hook and white rag while fishing off the flying-jib boom. Fishing in this manner became quite a sport. Taking position at the end of the flying-jib boom, the bait was dipped to the water's edge as the fish played under the bows of the schooner. They would strike like a flash and, until we were properly rigged for landing them, we lost several, they were such game fighters. It was necessary to rig a sack on the martingale guys to drop the fish in before attempting to take the hook out. At 5:15 P. M. the wind hauled to about NE. and brought a heavy rain storm, but no violent wind. Towards evening the wind hauled SE. and the schooner was put full and by, making three to four knots per hour. Lat. $8^{\circ} 19' N.$, Long. $106^{\circ} 45' W.$ at meridian.

1905

August 16: Opened with heavy seas and strong S.S.E. winds. Had some of the bonita we caught yesterday for breakfast. Wind and sea increasing towards 10:00 A. M., we took in the gaff-topsail and flying-jib. Some of the boys a little under the weather but able to stand watches. At 7:30 P. M. the strop for the starboard main lift carried away. Schooner making about ten knots. Lat. $7^{\circ} 53' N.$, Long. $105^{\circ} 22' W.$ by dead reckoning at meridian.

August 17: Opened with fresh winds from the southward. Schooner making about E.S.E. and logging six to ten knots per hour. Nelson and I busy repairing the main lift, while some of the watch below are sorting out the onions and potatoes and throwing the bad ones overboard, as our stock of vegetables is getting low. The navigator repaired some of the leaks in the centerboard casing. Late in the afternoon the wind died down and at 7:00 P. M. we were almost becalmed. Lat. $7^{\circ} 45' N.$, Long. $104^{\circ} 02' W.$ at meridian.

August 18: Opened with light airs and calms, with some light showers. This morning Beck shot a phalarope. Several petrels seen flying about the schooner. Heavy swells from the S.S.E. during most of the day. Crew variously employed, Stewart making a bookcase for the cabin. Very sultry towards evening with light showers during the second dogwatch. Lat. $7^{\circ} 25' N.$, Long. $103^{\circ} 40' W.$ at meridian.

August 19: Opened with regular doldrum weather; variable light winds interspersed with calms and rain showers. Considerable swell from the S.S.E. Took advantage of the calm weather to set up and repair some of the head gear. Current setting us to the E.S.E. magnetic during the last 24 hours. Lat. $7^{\circ} 18' N.$, Long. $103^{\circ} 11' W.$ at meridian.

August 20: Opened with fresh breeze from the southward with considerable swell. Lowered the mainsail and rove off a new lace line. Wind going down towards evening and at 6:00 P. M. the schooner was almost becalmed. Passed close to a couple of turtles floating on the surface. Crew variously employed, Williams sharpening up the porpoise harpoon for future use. Current still setting us to the eastward. Lat. $7^{\circ} 15' N.$, Long. $101^{\circ} 13' W.$ at meridian.

1905

August 21: Opened with light unsteady southerly winds, growing stronger towards noon. Considerable rain and heavy swell from the SE. On the morning watch the strop on the port main lift carried away. One shearwater and a large school of porpoises sighted this morning. Williams and White rigged up the porpoise harpoon. Schooner sailing full and by, logging two to four knots per hour. Lat. 7° N., Long. $100^{\circ} 13'$ W. at meridian.

August 22: Opened with fresh southerly winds and rain squalls. Heavy swell from the S.SE. Crew variously employed, Nelson making a rudder for the ship's boat. Schooner making two to five knots per hour. Current set us 18 miles E. $\frac{1}{2}$ S. magnetic during the last 24 hours. Lat. $6^{\circ} 10'$ N., Long $98^{\circ} 41'$ W. at meridian.

August 23: Opened with light southerly winds and rain storms. This morning a large school of porpoises crossed our bows, the cook trying to harpoon one without success. Some of the watch below helping Nelson repair the skiffs and ship's boat. Schooner making E.SE. four to five knots per hour. Lat. $5^{\circ} 51'$ N., Long. $97^{\circ} 26'$ W. at meridian.

August 24: Opened with strong southerly winds and occasional rain squalls. A few boobies, terns and shearwaters about the vessel. Schooner making SE. $\frac{1}{2}$ E., about four knots per hour. Current still setting us to the eastward, about 20 miles during the last 24 hours. Lat. $5^{\circ} 15'$ N., Long. $95^{\circ} 42'$ W. at meridian.

August 25: Strong southerly winds still continue. Making SE. by E., about four knots per hour. A tropic-bird and many schools of flyingfish sighted this morning. A perfect and beautiful rainbow sighted in the SW. This afternoon many boobies, shearwaters and terns about the schooner. A flyingfish flew aboard and was captured. At 10:00 P. M. the maintopsail sheet carried away and the mainsail was made fast for the night. Lat. $4^{\circ} 31'$ N., Long $94^{\circ} 08'$ W. at meridian.

August 26: Opened with cloudy weather and southerly winds. Schooner making SE. by E., about four knots per hour. Lowered the mainsail this morning and rove off a new topsail sheet. Hoisted sail again as soon as repaired. Crew

1905

variously employed, Nelson putting chafing strips on the skiffs. At 4:00 P. M. the wind gradually went down and at sundown we were nearly becalmed. Current setting us E. true, about one mile per hour. Lat. $3^{\circ} 39' N.$, Long. $92^{\circ} 54' W.$ at meridian.

August 27: Opened with fine sailing breeze. During the morning occasional showers passed over us. Schooner logging about six knots. At 5:30 P. M. we changed course for Cocos Island, it being decided to take advantage of the southerly wind, as we were not able to make much headway towards Culpepper Island. Williams put out a fish line this afternoon and caught a fine bonita, which we had for supper. Lat. $3^{\circ} 46' N.$, Long. $90^{\circ} 08' W.$ at meridian.

August 28. Opened with fresh southerly winds. Schooner making NE. by E., about five to six knots per hour. Weather cloudy and a few showers during the day. Nelson caught another bonita while fishing off the flying-jib boom. We are now making long tacks towards Cocos Island. Lat. $4^{\circ} 58' N.$, Long. $87^{\circ} 50' W.$ at meridian.

August 29: Opened with fine sailing breeze from S by SW. Cloudy weather with occasional rain squalls. Keeping a sharp lookout from the masthead for Cocos Island, our position being uncertain on account of our chronometer being out. At 6:00 P. M. took in maintopsail and flying-jib. The island not being in sight as darkness shut down on us, we took in the foresail and hove to for the night. Lat. $5^{\circ} 11' N.$, Long. $86^{\circ} 20' W.$ by dead reckoning at meridian. Too cloudy to get an altitude at noon today.

August 30: Opened with shifting winds and calms. Weather cleared somewhat towards noon and the navigator got a sight. At 1:00 P. M. set flying-jib, mainsail and foresail and tacked ship, making course W. Tacked ship again at 6:00 P. M., making course SE. by S. Found no northerly current here as shown on the chart. Lat. $3^{\circ} 51' N.$, Long. $86^{\circ} 05' W.$ at meridian.

August 31: Opened with cloudy weather and light SW. winds. Schooner logging from two to four knots. This morning several large schools of porpoises crossed our bow. Navigator got a sight at 8:00 A. M. and another at noon.

1905

putting us 100 miles off the island. At 3:00 P. M. rain began to fall and continued till 7:30. Sighted numbers of terns, petrels, frigate-birds and boobies flying towards the N.NE. Lat. $4^{\circ} 50' N.$, Long. $87^{\circ} 11' W.$ at meridian.

September 1: Opened calm with beautiful clear sky. At 5:30 A. M. Cocos Island was sighted from the fore cross-trees, bearing N.NE., distant about 35 miles. Light breeze sprang up during the morning and the schooner made N.NE., about two miles per hour. Many boobies, petrels and terns about flying towards the island. The wind failed us before noon and we were again becalmed. A great number of sharks swimming about the schooner, some appearing to be about ten feet in length. Williams saw great numbers of water-striders skimming over the surface. Counted six turtles apparently sleeping on the surface. One near the schooner was shot and hauled on board for the galley. After lunch went out in the skiff with Beck shooting birds. We collected some petrels, boobies, shearwaters and four loggerhead turtles. Weather cleared off at noon. Schooner becalmed about 30 miles SE. of Cocos Island, which is in sight from the fore crosstrees. Large schools of porpoises kept passing the schooner throughout the day. Towards sundown a waterspout was sighted about two miles off. The evening came upon us calm and clear, the schooner drifting slowly away from the island. At sundown we were about 35 miles off.

September 2: Opened calm, clear and warm. Beck went out in the skiff shooting birds. King and myself skinning turtles. Nelson working on sail for the skiff. Great numbers of sharks and porpoises about the schooner. Williams caught one shark about $7\frac{1}{2}$ feet in length. Found its stomach full of turtle meat we had thrown overboard. This evening a large devil-fish swam close under the counter. It looked to be seven or eight feet across. Schooner becalmed all day. Keeping her headed for the island when possible. At 5:00 P. M. the island was about 40 miles distant.

September 3. Opened with light breeze from the SW. At 5:30 A. M. we had the island about 18 miles off and at 10:30 had cut down the distance to about ten miles. At noon we were within two miles of the anchorage and still making a

1905

little headway. All hands much elated at the prospect of getting ashore, the island with its beautiful tropical foliage looking most enticing. After lunch helped Nelson bend a crown line on the anchor. At 1:10 P. M., on the 68th day of the voyage, we let go the port anchor in Chatham Bay in 11 fathoms of water. After spreading the awning and getting ready for port, Beck, Nelson and Ochsner pulled around to Wafer Bay to call on Captain Gissler and get his permission to land. Rest of the party preparing for work ashore. Great numbers of terns and boobies flying about the schooner. At 4:30 P. M. the boat returned bringing a watermelon and some cucumbers. Captain Gissler very kindly gave us permission to land and carry on our work. After supper a shore party landed at Chatham Bay, finding numerous hermit crabs in shells of many patterns and colors, sphinx moths, cockroaches, cicadas, which sing at night, earthworms, and very small stinging ants which seem to literally cover the dense vegetation. Nelson climbed a cocoanut tree and secured several nuts. Landing party returned to the vessel early and all hands turned in so as to get off early in the morning. Captain Gissler informed Mr. Beck that he had been on the island for seven years and that he is fully convinced that the famous Cocos Island treasure is buried there. He claims to have a chart showing the position, but lacks the deviation of the compass to locate the exact spot.

September 4: Breakfast at 6:00 A. M., after which the shore party in both skiffs pulled down to Wafer Bay, passing through the channel separating Nuez Island from the main island. We beached our skiffs at the mouth of a small creek entering Wafer Bay, close by Captain Gissler's house. Captain Gissler has a small corrugated iron house raised off the ground, like many or all houses in the tropical lowlands.² Back of his house is a small grove of banana trees, papayas, cocoanut palms and a small patch of tobacco. There are seven Costa Rican soldiers furnished by the government living on

² The writer again visited Cocos Island on board Captain G. Allan Hancock's yacht *Oaxaca* in December, 1927. Captain Gissler's house and all the out houses were in ruins and the rain forest had overgrown his garden and clearing on the small flat back of the houses. It presented a sad and desolate appearance compared with the day we received such a royal welcome from Captain and Mrs. Gissler on September 4, 1905.

1905

the island to prevent any intrusion. These men are under Captain Gissler, he being governor of the island. Gissler informed us that an Englishman, Earl Fitzwilliam, came to the island at one time to look for the buried treasure. After having an altercation with Gissler and doing some blasting in which he injured several of his men, two of them subsequently dying of their injuries, he left. Gissler conducted our shore party up the creek back of his house. Passing a tree in his garden, Williams caught two large butterflies. The creek proved to be on an average of eight to ten feet wide a mile or so from the beach and excellent drinking water. It is no wonder that the pirates, whalers and ships of war made Cocos Island a rendezvous for the purpose of watering ship. The vegetation along the creek was exceedingly dense and verdant, great tree ferns some 15 feet in height and huge palm trees 30 or more feet in height growing in abundance, while everywhere trees shut out the light from above and made the tropical forest quite dim. Ferns were everywhere and the trees covered with moss and creepers, while orchids could be seen on most every tree trunk. Little aboreal lizards (*Anolis torensendi*) hopped about on the leaves, resting wherever they could catch a ray of light or possibly sunshine between showers. Yellow warblers flying about stood out in bold contrast against the vivid greens of the forest trees. In the creek a crustacean somewhat resembling a shrimp and growing to a length of six or seven inches was quite common, as well as a small sucker which would creep up the rocks in midstream and rest there, wiggling off into the water on one's approach. The forest was covered with leaf mold and had a very rich soil. Many of the trees were 60 to 80 feet in height. Ramifying near the tops, their large cordate leaves formed a barrier over the sky. Some of these trees had a diameter of from two to three feet. Rotten logs about the forest floor proved a gold mine for the entomologist. From these were dug earthworms, millipeds, beetles and their larvæ, scorpions and centipedes. Termites and ants of several species were abundant. It commenced raining early in the morning and poured most of the day. At first the rain was checked by the great leaves overhead, but in the end all hands were soaked

1905

through. From this and later experience we found that there was no use of trying to keep dry on Cocos Island. It cannot be done!—at least in the rainy season. Returning to the landing place in the afternoon, we had lunch and Gissler gave us some luscious ripe bananas. At 5:00 P. M. the landing party was rounded up and we returned on board for supper. Thus did we spend our first day on the famous treasure isle. Nelson stayed on board repairing and overhauling rigging. An observation showed that our chronometer had been losing 46 seconds per day for the past 24 days.

September 5: Early breakfast this morning. Nelson, Ochsner and King started off on a pig hunt, but failed to bring home the bacon. Rest of the landing party collecting around Chatham Bay. We saw the names of several ships carved in the rocks about the landing place. The oldest of these was that of H. M. S. *Centurion* 177-.³ Scenery around Chatham Bay very picturesque. One or two fine waterfalls come tumbling down over the cliffs right into the ocean. Many interesting tide-pool fishes were plentiful and Williams caught several in his bug net. I secured a large series of lizards and Ochsner many shells. All hands on board again at 5:00 P. M. Williams caught several trigger-fish while fishing off the schooner. Rain most of the morning. Nelson working on rigging. Set up the forestay and bobstay.

September 6: Landing party went ashore at Wafer Bay. Williams and I went collecting up the creek back of the houses. Captain Gissler went aboard the schooner for lunch, returning in the boat coming in to take off the landing party. On returning from our hunt up the creek, Mrs. Gissler gave Williams and me several bananas, which were always welcome. Two large whales swam close by this afternoon. One looked to be almost as long as the schooner. Some rain during the day. Very damp in the cabin. Guns get rusty over night and everything in the way of leather goods gets moldy. Nelson set up some of the head gear during the day.

September 7: All hands up for early breakfast. All hands, with the exception of Stewart, who went ashore collecting, turned to with Nelson and helped set taut all the lanyards

³ Last figure obliterated

1905

on fore and main shrouds and topmast backstays, an all-day job. Started raining at 6:00 P. M. Everybody eating their fill of bananas, a most welcome addition to our bill of fare. At 8:00 P. M. a red light was seen rounding the point of the island and a two-masted schooner came in and anchored close by. In the morning she shifted her berth to Wafer Bay and unloaded supplies for Gissler. Rain stopped at 9:00 P. M. and we had a clear moonlight night.

September 8: Shore party landed at Wafer Bay. The schooner that came in last night proved to be a steam yacht flying the British merchant flag. She had some Costa Rican soldiers on board who were to report to Captain Gissler. I spent the day on board today and greased down the fore and main masts. In the afternoon went fishing with White, and, although there were many fish about, we could not get a bite. White fixed up a dish of fried bananas for supper this evening. Several heavy rain squalls this afternoon.

September 9. Began to rain heavily this morning, so no landing party went ashore. Went out in the skiff with Beck to see if we could get a few birds, but the rain drove us back. Rained heavily all day and at 6:00 o'clock it was still coming down in sheets. Took advantage of the heavy rain to water ship by hauling up the awning stops and putting a belly in it. We had previously sewed two canvas pipes on to the awning long enough to reach down into the tanks in the hold. By this method during our stop at Cocos Island we took in a six months' supply of water from the rain alone. It rains heavily at Cocos Island!! This evening I distinguished myself by winning three bananas; two off Ochsner and one off Gifford, by beating them at checkers.

September 10: No rain this morning and sky not so cloudy. Nelson went ashore at 3:30 this morning on a pig hunt, returning at breakfast time with a brown and black boar. Being Sunday, all hands indulged in a little recreation. Dinner at 2:00 P. M. Beck, Parker, Ochsner and Stewart took half of the pig killed this morning and pulled over to Wafer Bay to have lunch with Captain and Mrs. Gissler. Rained hard all afternoon and up till 10:00 P. M. Party returned from Wafer Bay at 11:00 P. M. after a dinner of chicken, fried

1905

bananas, whiskey, wine and beer. Heavy rains caused the water in the bay to become discolored. Captain Gissler sent us out a new supply of lemons.

September 11: Beck, Nelson, King and Stewart circumnavigated the island in one of the skiffs. They made one landing at Dampier Head, where Nelson secured several fine cocoanuts. Rest of the party landed at Wafer Bay. Mrs. Gissler treated us to some wine and lemonade. As we pulled in close to shore entering Wafer Bay, a large brown pig was seen heading up the hillside. Some heavy rains this afternoon.

September 12: Shore party landed at Wafer Bay. Williams and I went collecting up the stream back of Captain Gissler's house. With his butterfly net, Williams caught eight small birds. Saw a large sphinx moth flying about in the jungle. Cold pork for lunch today. Cocos Island pig is not bad when you can get a young one. Ochsner went pig hunting again today but failed to get any, shooting in the jungle being very difficult.

September 13: Shore party landed again at Wafer Bay to bid Captain and Mrs. Gissler good-bye. They loaded us up with bananas, papayas and eggs. We left letters with them to be sent back when the schooner came again with supplies. Nelson and Parker brought some pieces of hard wood on board for making repairs to blocks, etc. All hands returned on board at 2:15 P. M. and had lunch. At 3:00 P. M. started to weigh anchor, a long and hard job, as the anchor was much too heavy for our vessel. We were nearly an hour getting the chain hove short and did not break the anchor away till 4:00 o'clock, when we set sail for the Galapagos. Moderate SW. winds and heavy rain squalls during the afternoon.

September 14: Opened with fresh southerly winds and overcast sky. Some rain during the morning. Schooner sailing full and by, making two to four knots per hour. Shearwaters now appearing and several sharks about the schooner. Ornithologists busy skinning birds taken on the island. Lat. $4^{\circ} 14' N.$, Long. $86^{\circ} 35' W.$ at meridian.

1905

September 15: No change in wind or weather. Schooner still on the wind, making SE. $\frac{1}{2}$ E. one to four knots per hour. White made us cocoanut pie for dinner today. Several schools of porpoises passed close to the vessel this afternoon. All hands at work on their specimens and standing watches. Lat. $3^{\circ} 05' N.$, Long. $84^{\circ} 13' W.$ at meridian.

September 16: Opened with strong SW. winds. Considerable swell running this morning. Took in flying-jib and gaff-topsail. All hands enjoying the fruit taken on board at Cocos Island. Hunter and White busy killing off some of the bed-bugs which are getting so numerous they make the nights too interesting. Weather quite cool and pleasant. Lat. $1^{\circ} 33' N.$, Long. $82^{\circ} 24' W.$ at meridian.

September 17: Opened with fresh southerly winds and choppy sea. During the 4:00 to 8:00 watch this morning the schooner was making heavy weather of it and shipped green water over the bow, flooding the cabin. Wind calmed down during the afternoon and we set the flying-jib and gaff-topsail. The gaff-topsail tack carried away this afternoon and caused some trouble till repairs were made. Great numbers of flyingfish were seen today. Lat. $0^{\circ} 10' N.$, Long. $80^{\circ} 52' W.$ at meridian.

September 18: Opened with light southerly winds and fair weather. Schooner on the wind making S.S.E. Several tropic-birds passed us flying to the southward. Crossed the line today and had our first view of the snow-capped Andes of the equator. At noon Cape San Lorenzo bore by compass SW. $\frac{3}{4}$ W., distant 29 miles. Lat. $0^{\circ} 40' S.$, Long. $80^{\circ} 42' W.$ at meridian.

September 19: Opened with cloudy weather and moderate sea. Fresh wind from W.S.W. This morning we were about nine miles off the land, the coast line appearing precipitous and covered with forests. Several conical peaks of the Andes plainly visible back of the coastal hills. At 5:00 P. M. we made up to Manta Bay and passed a sloop laying to, close under our port bow. Several other sail in sight. Wind hauled to the westward and we passed within a few miles of the port of Manta, the adobe houses and corrugated iron roofs being plainly visible. A three-masted ship was laying at

1905

anchor off the port. At 8:00 P. M. we weathered Cape San Lorenzo and stood out on the port tack. Lat. $0^{\circ} 27' S.$, Long. $82^{\circ} 40' W.$ at meridian.

September 20: Opened with strong southerly winds with cloudy and slightly misty weather. Quite cool for this latitude. Schooner on the port tack, making W. by S. $\frac{1}{2}$ S. and logging five to six knots per hour. Phalaropes, terns and a tropic-bird seen. Lat. $0^{\circ} 33' S.$, Long. $85^{\circ} 03' W.$ at meridian.

September 21: Opened with steady southerly winds which grew weaker towards noon. Sky cloudy and some showers during the night. On the midwatch last night five flyingfish flew aboard. These were caught and turned over to the cook. We found them excellent eating. Several sharks and many flyingfish sighted today. Lat. $0^{\circ} 37' S.$, Long. $86^{\circ} 52' W.$ at meridian.

September 22: Opened with unsteady southerly winds. Tacked ship at 5:35 P. M. and again at 12:15 A. M. Schooner making SW. by W. and logging from four to five knots. Small drizzle during the night. Lat. $1^{\circ} 06' S.$, Long. $88^{\circ} 28' W.$ at meridian.

September 23: Opened with partly cloudy weather and fresh southerly breeze. 12:10 A. M. we tacked ship, going on the port tack. Wind died down towards afternoon and at 3:30 P. M. Chatham Island was sighted. Some gulls, petrels, shearwaters and two albatrosses flying about the schooner. All hands making preparations to land and commence work on shore. Fine clear evening.

September 24: No change in weather. At 3:00 A. M. we tacked ship and again at 4:30. At 6:00 A. M. we set course for Hood Island, arriving at Gardner Bay at 8:30 and letting go the starboard anchor in $4\frac{1}{2}$ fathoms of water. Awnings were spread and vessel made ready for port, while all hands enjoyed their first close up view of the Galapagos, a region that never ceased to be of interest during an entire year that followed. After securing ship, sent a hunting party ashore for goats to get fresh meat for supper. Ochsner returned shortly with two kids and two bucks, giving us an ample supply of meat, a most acceptable addition to the bill of fare, as

1905

we have had none since we left Cocos Island. From the deck of the schooner we could see large numbers of hair seals scattered along the beach opposite which we were anchored. At 5:00 P. M. Williams and I pulled in to the landing place to pick up Gifford and Beck, who brought us in our first sea iguana. Ochsner and Hunter busy skinning a couple of goat heads and the rest of the party preparing for work ashore in the morning.

September 25: All hands turned out for breakfast at 6:00 A. M. and landing party went ashore collecting. Nelson remained on board to overhaul the mainsail. While pulling in for the beach many seals followed the skiff, one large bull coming particularly close as if to make a lunge at the steering oar. Here and there on the dazzling white sands of the coral beach lay sleeping seals. They could be approached without any fear on their part and even slapped with one's hands, when they would awake, and, with much din, rush clumsily into the water. Scattered about the rocks were numbers of sea iguanas, at this time of the year brilliantly marked with large blotches of red and green. They ran with shuffling gait over the sharp lava rocks, but would not take to the water unless they were pressed too closely, no doubt being afraid of the sharks which abound in these waters. These iguanas feed solely on seaweed which they gather off the rocks at low tide, their long, sharp claws enabling them to hang on to the rocks so that even a heavy swell breaking over and entirely covering them will not wash them off. As we stood on the beach looking seaward, several large sharks and mantas could be seen just at the edge of the outer breaker line. Nelson hooked three sharks from the deck of the schooner after landing the shore party. Going inland, we found the island covered with many species of low-growing bushes, some of which were covered with thorns and made walking difficult at times. Immense tree cacti were abundant. These cacti had heavy reddish brown trunks devoid of spines, the branches with large, flat leaves commencing to grow out five or six feet above the ground. They make excellent shelters and are the favorite haunts of flocks of goats which get under them for rest and shade. As well as with former visitors to the islands, we

1905

found the birds to be exceedingly tame, Williams knocking down a heron with a stone. Mockingbirds were particularly trustful and hopped about the ground within a few inches of one's hand while we were engaged in turning over pieces of lava in search of insects, etc. While we were eating lunch, they would even alight on one's knee and pick up the crumbs dropped. The little finches could in many cases be caught with a butterfly net and the ground doves could be knocked over with a stick. Everybody enjoyed their first day ashore and came back laden with specimens. A couple of sacks full of sea iguanas brought aboard were put into a cage prepared for them. One landing party returned to the ship at 5:15 P. M., and the other, which went to the albatross colony, at 5:50, the latter party being loaded down with albatrosses and several other species of sea birds. What is said in regard to the tameness of the birds can also be said of the lizards. These could be killed with a switch and, like the birds, would come and pick up crumbs that dropped to the ground under one's feet. Stewart struck at the tail of a lizard with his knife, severing the tip. The lizard did not move until it perceived its wriggling tail, when it promptly turned about and grabbed it, no doubt thinking it was some insect. All hands, on returning on board, kept busy well into the evening caring for their specimens. Ornithologists sat up late skinning birds. We now have goat meat every night for supper and cold goat for lunch. We found by later experience that it is best to forage off the land when possible.

September 26: All hands up for 6:30 breakfast. Landed on the northeast end of the island with Williams, Ochsner, Stewart and White. Found lizards abundant everywhere and captured three snakes, also some geckos by splitting open the trunks of dead trees. White caught a centipede ten inches long. Ochsner found land shells abundant and shot another goat for fresh meat. Had a small shower of rain this afternoon. King stayed on board and helped skin the 24 albatrosses taken yesterday. They were finished up late in the evening. All hands aboard for six o'clock supper.

September 27: Went ashore on Gardner Island with Williams, Ochsner and King, the rest of the party landing on

1905

Hood. Found the fauna about the same as on Hood. Sea lions abundant and very tame. Counted 13 sea iguanas on a single small rock. No goats on Gardner Island and the vegetation not so dense as on Hood. Beck reported going to the summit of Hood and finding a few old tortoise bones. He knocked down and killed a hawk with a stick. Weather fine and temperate. Still enjoying our goat suppers. All hands generally ready to turn in early.

September 28: Went down to the albatross colony with Beck, Hunter, King and Williams, the latter keeping the boat, as the shore is rough lava at the landing place and it is impossible to beach it. Collected some sea iguanas and a few green turtles. Beck shot a nice pair of goats for fresh meat, also two bucks with fine, large horns. Remainder of shore party landed on Gardner. Nelson aboard today tarring rigging. Parker keeps anchor watch during the night. First mosquitos for the Galapagos heard this evening. Beck found some large centipedes in the stomachs of two hawks he killed. Temperate weather with fine, clear evenings.

September 29: Remained aboard ship today preparing sea iguanas to put in alcohol and skinning sea turtles. Williams and Ochsner visited the southeast end of the island today. Williams caught a centipede ten inches long, a snake and some geckos. Between the two of them, they killed 32 doves with sticks and stones and brought them back to the cook to make a dove pie. Weather warmed up some today. Ornithologists busy every evening skinning birds. Fine, clear evening with new moon.

September 30: Shore parties on both Hood and Gardner islands. Williams and Ochsner, visiting the north end of Hood, secured some large and excellent crayfish besides many interesting shells. While sitting in the stern of the skiff, which they had beached, a large bull sea lion approached within a foot or so of the stern as if to make a rush at the occupants. Williams struck him with an oar, whereupon he made a wild dash for the water. As on most of the beaches of Hood Island, numbers of sea lions were scattered about. A mother with young, being approached too closely, valiantly protected her offspring by making short rushes and snarling at

1905

the intruder. All hands aboard at 6:00 o'clock for a dove pie supper. Nelson shot three goats for the larder today. Weather pleasant and partly cloudy.

October 1: Being Sunday, we had late breakfast. Crew variously employed overhauling shoes, collecting gear, etc. Parker and Ochsner went ashore to kill a couple of sea-lions for oil. A light shower this morning. Sunday dinner at 3:00 P. M. and supper at 8:30.

October 2: Visited the albatross colony and kept the skiff while the landing party was ashore. Williams collected a snake and some geckos besides the usual catch of insects. Beck shot two more goats for fresh meat. Nelson and Parker took down the awning today and made the vessel ready for sea. At 8:30 P. M. weighed anchor and shaped course for Gardner Island near Charles.

October 3: Gardner Island sighted at 2:30 A. M. At 2:45 tacked ship and hove to, island bearing NW. by W. $1\frac{1}{2}$ W. At 7:00 A. M. made course for island, arriving off of it at 9:30. Nelson landed Williams, Hunter, Ochsner and myself on a steep ledge over which swept a heavy swell. Hunter lost his shotgun making the landing and we all got thoroughly soaked. Finding it difficult to reach the top of the island from this landing, Williams, Ochsner and myself got back into the skiff and pulled to the northeast side, where climbing is easier and we could reach the top more readily. Hunter and King scaled the cliffs rather than take a chance getting back into the skiff. We found the north side of the island covered with cacti and brush. Frigate-birds, doves, mockingbirds and little ground finches were found in large numbers. I collected a snake and the usual number of lizards. All hands returned on board at 1:30 P. M., when we shaped course for Champion Island. At 3:00 P. M. made up to Champion and landing party went ashore while the schooner lay to off the island. Collected some lizards and some beetles, spiders and centipedes for Williams, as he did not go ashore. Landing party returned to the schooner at 5:00 P. M. and we shaped course for Postoffice Bay, Charles Island, where we arrived at 6:00 P. M., dropping anchor in $4\frac{1}{2}$ fathoms. From this anchorage Charles looks quite barren except for a

1905

few places along the coast and the tops of the numerous peaks. Several of the larger islands visible from here.

October 4: All hands up for 6:30 breakfast. Beck landed near a lagoon at the northeast end of the bay, while the rest of the party landed opposite the anchorage. Here we found the postoffice after which the bay is named. It consisted of a barrel erected on top of a post and painted red. An inscription on the post reads: erected by H. M. S. *Leander*. Crews of various vessels calling at this anchorage had painted or carved the names of their vessels on the post or barrel. Among these are: His Majesty's ships *Amphion* and *Virago*, the French cruiser *Protet*, the U. S. S. *Oregon*, and the U. S. F. S. *Albatross*. This postoffice was no doubt frequently used in former days when the whale ships cruising these waters would sometimes make voyages of a year or more. The idea was that any ship homeward bound should pick up the letters, mark it ships mail, and, on delivery in the United States, it would be forwarded to the main postoffice at Washington, without postage stamps being attached. Mr. Gifford wrote to his father in Alameda, California, and mailed a letter in the barrel. We found out on our return that it had been picked up by the British yacht *Deerhound* and forwarded to Washington. The rust from the barrel hoops had obliterated part of the address, so that all that could be deciphered was—Gifford, Alameda. The postoffice at Washington traced the addressee and delivered the letter. On our return, the postoffice department, at its request, was furnished with full details as to the origin of the letter. Footprints on the beach showed that the postoffice had been visited shortly before our arrival. Williams and I struck off inland and climbed a rounded hill some 600 feet in height. All about us could be seen truncated cones and peaks of various sizes. The entire island seemed to be covered with brush and small trees. Williams got a few insects and Ochsner some land shells, but no snakes or lizards, except geckos, were seen. We saw cat tracks, signs of wild cattle, and heard the braying of a donkey, but did not meet with any. On returning to the beach, we all enjoyed a swim after a hard day bucking through the brush.

1905

October 5: Went to the lagoon at the northeast end of the island. The water was not very salty and Williams caught some aquatic insects. I found one lizard besides the usual number of geckos. The cats have about exterminated the *Tropiduri*, and the wild dogs the sea iguanas on Charles Island. A flock of about 13 goats was seen. They were very wild and disappeared around a large conical hill as soon as they were sighted. No doubt wild dogs had driven them away from the fertile part of the island to this dry and barren portion. Parker and White went fishing over the side and caught several nice fish, which we had for supper. Weather rather warm today with nice, clear evening.

October 6: Beautiful morning, calm and clear. Visited the lagoon again with Williams, Beck, Hunter and Ochsner. Hunter shot six teal ducks and three flamingos. The ducks were very tame and I killed one myself with a 22 rifle and dust shot cartridge. I also got five lizards besides geckos; good luck, as they are very rare on Charles Island. All hands were back on board at 11:30, when we weighed anchor and set course for Black Beach Anchorage, sailing by the wind along the west side of the island. We reached Black Beach at 2:30, letting go anchor in 11 fathoms of water. We found a sloop from Chatham at anchor here. It had brought over a hunting party to kill wild cattle and jerk the beef for the settlement. Black Beach is a long beach of black sand with a cross, bearing no inscription, erected at the north end of it. The landing place, which is the terminus of the trail leading to the interior, is just to the northward of the cross. Beck, Ochsner and Nelson landed and found a party of natives cutting up beef and hanging it up to dry. Ochsner gave them some whiskey from our medicine chest and they seemed to relish this beyond everything. The word whiskey was the extent of their knowledge of the English language. They gave some nice, juicy oranges in return, saying that there were plenty and also plenty of fresh water up in the hills. The man in charge of the hunting party came aboard with two sailors and brought us some fresh beef. Black Beach Anchorage not so good in heavy winds, as it is merely an open roadstead. Cloudy and cool towards evening.

1905

October 7: Landed at the camp of the hunters and started for the spring back of the highest peak on the island. With Williams and Ochsner, walked up to the base of the peak, which King and Stewart proceeded to climb. They reported the top to be bare, but in the crater they saw much damp soil and numerous ferns and rich vegetation. Working around the northern base of the peak, we found some small groves of orange trees and an immense thicket of lemon trees, forming an almost impenetrable mass. We had a good feast of oranges, which were sweet and juicy. Continuing on up the trail, we met a peon bound for the beach and driving three burros loaded down with beef and hides. Further on we saw a young pig some of the hunters had captured and tied to a tree. We found the spring in a very delightful situation at the base of a small bluff, from the top of which we could see the crater of the main peak and much open pasture land between the thickets of lemon trees. Williams collected quite a number of insects and Ochsner a number of land shells. Land shells were very abundant here, the trunks of some of the small trees being covered with them. We ate our lunch in the shade of a clump of lemon trees situated on the summit of the pass and enjoyed seeing the many little birds hopping around in the nearby trees, without the slightest fear, and eyeing us with the greatest curiosity. On our return to the beach, a peon, to whom Ochsner gave some whiskey, presented him with some oranges and a penguin stuffed with sand. All hands aboard for 6:00 o'clock supper, consisting of beef soup, teal duck, flamingo, corn-starch pudding and ripe oranges, quite a variety for a desert island. Flamingo tastes somewhat like duck but is a little drier and more oily.

October 8: All hands up for late breakfast, today being Sunday. Beck and Gifford went ashore for a short time this morning to take some photographs, and brought back with them the chief of the hunting party, who stayed for dinner. He informed us that Manuel Cobos, formerly owner of the plantation on Chatham, was killed two years ago and that one of the men who helped kill him is in his crew on shore. Just a month ago a member of his hunting party was killed in a fight, so we are not far wrong in judging from the looks of

1905

his party that they are a bunch of desperados. The camp cook, the only female in the party, looks like she could cut anybody's throat with pleasure. We were also informed that there are about 100 people on Albemarle Island, all free men, and about 300 on Chatham, mostly all exiles and slaves. All hands variously employed this afternoon mending shoes and preparing for work on shore tomorrow. Fine, clear day and balmy evening.

October 9: All hands up for early breakfast and everyone, except Nelson and White, went ashore. Parker went up to the orange trees to bring back a sack of oranges for the mess. Williams and I went up to the springs. Enough water drops and runs off the vegetation to form a little pool at the base of the cliff. The water is clear and cool and is excellent for drinking purposes. The spring is an excellent place to fill a canteen, but too slow and too far away from the shore to water a vessel. Around it are several fine orange and papaya trees. From a hill just above we saw several wild cattle feeding in a little open space close by the lemon thicket. Near the spring we met a sailor off the Chatham sloop with a burro train. He said he came up to get a load of meat, as the sloop is to sail for the settlement this afternoon. Nelson took some letters over to the captain so they could be sent to Guayaquil when the trading schooner left for the mainland. Returned to the landing at 5:00 o'clock and Williams and Nelson went out fishing in the skiff, catching several nice fish, which we had for supper. Weather fair with slight rains in the interior of the island.

October 10: Went ashore with Nelson, Williams and Ochsner. Nelson was going to try for a pig, but failed to get any. He brought back a sack of oranges instead. We found by experience that the early morning or night time is the best time to hunt for pigs. Ochsner reported seeing a pack of dogs chase a band of cattle, which bunched together and warded them off. Williams and I climbed about half way up the highest peak and reached the lower rim of the broken down crater when the rain drove us down to the lower levels. We then went across a long and green, open meadow, where we counted 35 fine looking wild donkeys and a huge black

1905

bull. We ate our lunch at the head of this meadow, from where we could see the ocean on the other side of the island. Returned to the landing at 5:00 o'clock and found that the sloop had left for Chatham Island.

October 11: Spent the day with Williams in the vicinity back of Black Beach. Collected a number of geckos and Williams got a number of grasshoppers, which were particularly abundant at this locality. King went up to the divide and brought back a sack of lemons. Very windy today. Towards noon it increased so, the schooner started dragging anchor, and Nelson veered chain to 45 fathoms.

October 12: Went up to the divide to help Williams carry down some oranges and lemons. On returning to the beach, we found that the sloop had returned, carrying the secretary of the Governor and an escort of five or six soldiers under command of the captain in charge of the soldiers stationed on Chatham. A Jamaican negro accompanied the party as interpreter. The secretary brought us letters and papers from home, the first news in 107 days. We entertained the secretary and the captain of the guard at dinner, and one would think, judging from their appetites, that they never had anything to eat in their lives before. The secretary gave Beck a letter written in Spanish to the effect that it is customary for vessels visiting the islands to call at Chatham first.

October 13: Early in the morning Beck went ashore to interview the secretary and decided it best to go direct to Chatham as requested. We took the whole party on board the schooner: secretary, captain, interpreter and five soldiers. The latter made a fine looking army. One had an old French army hat about the vintage of 1880, some had no hats nor sandals, but were the proud possessors of undershirts and trousers, which seemed to be the uniform of the day. Their firearms were about the same period as the uniform hat and were old bolt-action rifles. One had a double-barrel shotgun, the firing pins of which were rusted fast. No ammunition at all was in evidence. No doubt it is too dangerous to let the soldiers get hold of any cartridges. However, what the army lacked, the commanding officer supplied. He was dressed in a light blue uniform of French design, with red epaulets, red stripe down

1905

his trousers, a huge red pompon on his hat, and a cavalry saber that, for size and polish, was the last word. The secretary and the captain had breakfast with us, and the latter having ordered the army on board, we weighed anchor and set sail for Chatham. The wind died down towards evening and at 8:00 P. M. we picked up the Chatham light. We tried to beat up to Wreck Bay, but the current setting us off, we made no headway. At 10:00 P. M. tacked ship and stood off the land. Nelson and King slept on deck so as to give the secretary and captain a stateroom. All hands except the deck watch turned in early and wished our guests a good night, trusting that the bedbugs would not drive them out before daybreak.

October 14: Opened with light airs and calms. At 1:00 A. M. tacked ship and stood in towards Chatham Island, making about SE. by E. with current setting against us. At 6:00 A. M. Dalrymple Rock bore S. by E. by compass, distant five miles. Put out the skiff this morning and Beck went shooting birds, securing about 30 or more shearwaters. Sighted great schools of tuna jumping out of the water, while numbers of birds hovered over them. At 11:00 A. M. a breeze sprang up to the southward and we made up to the anchorage at Wreck Bay, letting go anchor at 3:45 P. M. in 7 fathoms of water. The secretary, captain and army landed immediately, as well as our own shore party, going to make an official call on the Governor. The settlement at Wreck Bay consists of a warehouse, the plantation manager's house, several native huts and the light keeper's house. The Wreck Bay light consists of a lantern placed on the top of a pole. The sugar plantation and upper settlement can be seen from our anchorage and is about five miles inland. Towards evening a good breeze was blowing off the land and the anchor watch was set for the night.

October 15: All hands up for late breakfast, being Sunday. Williams and Beck went ashore to call on the plantation manager, an Italian who spoke some French. Williams acted as interpreter, speaking in French. They had dinner with the manager and some of the engineers from the sugar mill, after which the party came on board to visit the schooner. The

1905

manager gave us permission to hunt about the island and was very cordial in his welcome. In the afternoon went ashore with Williams, Gifford and White to visit the settlement. The country looked very green and luxuriant at this time of year. The wild cotton was in full bloom, having large yellow flowers not unlike those of the Mariposa Lily. An hour and a half walk over a good but somewhat muddy road brought us to the settlement, which consists of quite a number of corrugated iron buildings, the grass huts of the laborers, and the sugar mill. We were escorted to the headquarters of General Plaza, who conversed with us through a Jamaican negro acting as interpreter. The General was found seated at his official desk, an old kitchen table with the drawer missing, attired in a white duck suit and a navy watch cap, probably donated by some sailor off of a visiting warship. He gave us some very powerful home brew to drink, and, when he observed the tears streaming down our cheeks, informed us that it may be a little strong for us, as we were not used to it. Personally I agreed with him, in that it was not only a little too strong but much too strong for any human being. After this, I took particular pains not to be included in any official visits. Even now, 25 years afterwards, whenever I think of General Plaza I can almost feel my insides on fire. The General seemed very much interested in our work when we informed him as to our plans and where we were from, etc. The interpreter then said: "The General says he can tell from your looks that you are gentlemen." This remark rather flattered us, as we had been out 110 days without a shave and only at our stop at Cocos Island had we fresh water to wash with. Concluding our visit with the general, we invited him to come visit the schooner and started back to the beach, arriving there at 6:30 and getting on board the schooner in time for supper.

October 16: All hands up for early breakfast and shore party landed for collecting. Nelson finished making a sprit-sail for the ship's boat. Beck and Williams went up to the sugar mill, Beck taking several photographs of the place. All hands aboard for supper at 6:30.

October 17: Shore parties collecting about Wreck Bay. Weather rather warm with light drizzle. Butterflies were

1905

numerous along the road en route to the settlement and collecting good in general. Nelson tried out the ship's boat with the new sail and found it satisfactory. He picked up the shore party and sailed back to the schooner. Williams put out a fish line and caught a fine barcalau on the way.

October 18: Shore party landed at 6:30 A. M. for half a day's collecting. During the afternoon had strong winds from the S.S.E. and schooner dragged anchor. Beck arranged with the Governor to buy an old anchor to take the place of the one lost at Socorro Island, as our spare anchor was much too heavy to handle, and the kedge, despite the fact that it had some chain wrapped around the shank to give it weight, much too light to hold the schooner even under ordinary conditions. At 3:30 P. M. we weighed anchor and set mainsail and jib to sail up to the wharf and take aboard the anchor. In stopping the vessel's headway with the kedge, one of the flukes broke off. We got a line on to the wharf and ran another to the beach to hold the schooner off, as there was considerable ground swell running. Taking the anchor on board, we shackled it to the starboard chain and let go all lines, heading out of Wreck Bay for Barrington Island. Weather somewhat foggy with S. SE. wind.

October 19: Sighted Barrington Island at 12:15 A. M., we being close under the eastern point of the island when the fog lifted. Tacked ship and stood off the island till 3:00 A. M., when we tacked again and steered S. by W. $\frac{1}{2}$ W. At 4:00 A. M. the island bore S.S.W., distant six miles, there being a very strong current setting to the NW. Weather foggy during the night and part of the forenoon. Wind unsteady but mostly from the SE. Had fresh breeze during the forenoon and beat up towards the island. At noon the anchorage bore S., distant three miles. During the afternoon the wind fell light and we drifted away to the northward again. Center of the island bore S. at 8:00 P. M., distant six miles. Had fresh southerly winds during the night and stood close hauled on the starboard tack.

October 20: Tacked ship at midnight standing towards the island with fresh S.S.E. wind. Tacked again at 3:30 A. M. At 4:00 A. M. the island bore W.S.W. Tacked again at

1905

6:00 A. M. and headed for the anchorage, where we arrived at 8:00 o'clock, anchoring in 11 fathoms of water. After breakfast, landing party went ashore collecting. Fine sand beach opposite the anchorage, on which were a great number of sea-lions. Pegs driven in the ground for stretching out hides to dry showed us that it had been the camping place of some hunters. Beck shot a couple of goats, always a welcome addition to our larder. On the plateau near the top of the island we found a large colony of land iguanas (*Conolophus pallidus*).⁴ Small birds were found to be somewhat scarce, but hawks quite plentiful. Nelson caught several barcalau while trolling from the skiff.

October 21: Landing party ashore collecting. Went up to the land iguana colony with Gifford to take some pictures and then worked over to the south side of the island with Williams. We found no beaches here, but the coast line ending in precipitous cliffs. For a small island, Barrington has quite a goat population, as we saw many flocks during our trip across the island. The Barrington goats are not nearly so fat and healthy looking as those on Hood. Fine weather, with warm, sunny day.

October 22: All hands keeping the Sabbath. Nelson went out fishing in one of the skiffs and caught four fine big barcalau. Weather fine with light southerly winds.

October 23: Landing party ashore collecting. King and I went in to the iguana colony and collected a series of iguanas, packing them down to the beach in sacks. Still warm and pleasant with light southerly winds.

October 24: Landing party ashore for half a day's collecting, returning at 11:00 A. M., when we weighed anchor and shaped course for Indefatigable Island. At 3:00 P. M. we made up to the SE. coast and dropped anchor in six fathoms at Puerta de la Aguada. Heavy swells made the schooner roll considerably and, further in towards the beach, we could see that hidden reefs caused big breakers to go rolling in. Beck, Nelson, Ochsner and Williams took the big skiff and pulled in for the beach, bringing a water breaker in case any

⁴ On a second visit to Barrington some months later, this colony was found to be nearly exterminated by some natives from Chatham who had visited the island

1905

fresh water was found. The party encountered a rough trip, going in between reefs where the breakers rolled in high. The beach itself is fine white sand with gradual slope and well protected by reefs outside, so that it affords an excellent landing place. About a hundred yards back of the beach was found some comparatively fresh water in a half dried-up lagoon surrounded by a thicket of willow-like trees. About half a breaker of water was taken and found fit enough for washing purposes only. The boat's crew had a hard pull back owing to the heavy swells, which sometimes broke close on to the skiff.

October 25: At 5:30 A. M., Parker, who was on anchor watch, rushed down below and called to Nelson to let go the port anchor, as we had started to drag with the one anchor down. The heavy swell at this anchorage makes it a poor berth. The shore party left the schooner at 6:30 A. M., taking both skiffs in. On landing and hauling up the skiffs beyond the high tide line, all hands headed inland towards the base of a hill about two miles off, as in this direction appeared the best looking tortoise country. We found the going very rough, the country being covered with a dense growth of cacti and thorn bushes. Mockingbirds and doves were quite plentiful and tame. Near the base of the hill, Beck discovered a small tortoise, which King and I proceeded to skin, while the rest of the party went looking for more. All hands rounded up early in the afternoon where King and I had skinned the tortoise and Hunter and King carried it to the beach. Beck, Williams and myself started for the beach by another route. We found two tortoises' nests alongside our trail and, digging down, discovered 11 eggs in one and 12 in the other. The eggs are white and spherical, about the size of a billiard ball, and with a hard and thick shell. Close to these nests we found two very large tortoises, one a male and the other a female. The latter we killed and took out the liver to bring back for supper. The male tortoise was turned over on its back and all four legs stretched out and made fast with lashings to the nearby trees so he would not travel inland and make us pack him further on the following day. The shore party got back to the landing place about five o'clock, reaching

1905

the schooner at six after a hard day's work, but nothing to what the morrow had in store for us. Cloudy weather during the day with S.S.W. winds.

October 26: All hands up early and hoisted the port anchor. After breakfast landing party went ashore and made for the spot where we had killed the tortoise yesterday afternoon. Had some difficulty following the trail, but, by the use of a machete, we improved it for future use. On arriving at the spot where we had tied up the big male tortoise, we discovered that, in his struggles for freedom, he had dug a miniature crater in the ground, broken all the lashings, the ends of which were still fast to the trees, and had traveled a considerable distance up the hill, where we found him after following his trail through the tangled undergrowth. All hands started skinning operations at once and we had both tortoises skinned out by three o'clock in the afternoon. They were then lashed on poles with a blanket wrapped around each end of the pole so that they could be carried on the shoulder. With two men to a tortoise, we began the journey to the landing place over rough lava and through heavy undergrowth, which had to be cut away at times to make way for the packers. The tortoise packing was worked in relays, as it is hard on the shoulders despite the padding of blankets. We packed for about 20 minutes over the rough country and 30 minutes over the smoother parts and then took a relief for the same period. It took about three hours to reach the landing place, after a long and hard journey. We had tortoise liver for supper this evening and found it a little oily and of a peculiar taste, but not at all bad when one becomes accustomed to it. During future times on the expedition we always lived on tortoise liver when obtainable, with the exception of that of the Duncan Island tortoises, which we found to be dark and tasteless. The liver of the Indefatigable tortoise is rich yellow, as is that of the tortoises of all the other islands except Duncan. Weather cloudy during the day with moderate southerly winds.

October 27: Stayed on board with King and worked cleaning up the tortoises taken yesterday. Rest of party ashore collecting. Williams reported seeing a great many hawks about

1905

and collected seven of them for the ornithologists. While King and I were cleaning up the tortoises, we put the shark hook overboard and hooked a ten-foot shark. Shore party returned at six o'clock. Beck brought in a small live tortoise and reported having found another fair-sized one, which we will pack out tomorrow. Had a slight drizzle today.

October 28: Landing party ashore collecting. Williams, Beck and myself went inland and skinned and packed out the tortoise found yesterday. Our shoulders are getting sore now after the past few days and packing is becoming somewhat painful. We reached the landing place at 6:30 after a hard afternoon's journey.

October 29: All hands turned out at 5:00 A. M. Got under way at 6:00 A. M., shaping course for south Albemarle. Weather slightly foggy with S.S.W. breeze. At 9:00 A.M. the wind hauled to the S.S.E. and we had fine weather the rest of the day. The schooner was kept on the port tack until 7:30 P. M., when we were close on to the coast of Albemarle. We were too late to make an anchorage, so kept beating back and forth between Brattle Island and the south coast of Albemarle. Light winds and clear weather during the night.

October 30: At 8:00 A. M. hove to off the west side of Brattle and landed a shore party. Brattle Island is a broken-down crater rim with steep sides, no sand beaches, and poor landing places. We found a rock we could jump ashore on and scramble up the side of the crater. On reaching the top, we found the island to be crescent-shaped, the inside of the crater rim being precipitous cliffs straight down to the water's edge. We collected some sea iguanas, lizards, snakes, grasshoppers, beetles and scorpions. Very few plants were secured, as the island is almost destitute of vegetation. At 10:45 the schooner ran down before the wind and took off the shore party, when we headed for Turtle Cove, south Albemarle. We arrived at the anchorage at 1:15 P. M., letting go anchor in two fathoms of water. Anchorage is well protected by outlying reefs, but is only suitable for small vessels. Dipped our colors to the Ecuadorian flag on shore and cleared up decks, making ship ready for port. Three men and a Jamaican negro as interpreter boarded the schooner. We asked about obtain-

1905

ing water ashore and were informed that there is plenty, and good drinking water. Beck, Nelson, Ochsner and White went ashore, returning early in the afternoon with two small water-melons presented to them by Don Antonio Gil, the owner of the settlement. They reported the water as hardly fit to drink but good enough to wash clothes in. A party from the settlement is coming aboard after supper to visit the schooner. Fine, clear weather with S.S.E. winds.

October 31: Started watering ship with south Albemarle water, a rather slow process, as it has to be carried from some little distance inland on mules, two small casks to a mule. Took on 150 gallons during the day. All hands took advantage of the opportunity to wash clothes this morning. This afternoon swung the main boom out to port in order to list the vessel for cleaning and painting. Sunny, pleasant weather and plenty of mosquitoes on board.

November 1: Shore party working about the vicinity of the settlement. Williams, Ochsner and myself went up the road leading to Santo Tomas, the upper settlement situated on the edge of the forested area of Vilamil Mountain. The road slopes very gradually from shore, winding about the lowlands and passing through scattered groves of trees. A native who had a small garden which we passed presented us with a water-melon and a papaya, both of which tasted very good and were quite a luxury to us, as we had not tasted fruit for some little time. Found collecting in our various lines quite productive. Returned to the beach at 4:30 P. M. and had a visit with Don Antonio Gil. The natives were quite interested in looking over our catch and gave Ochsner's pistol a minute examination. Nelson and Parker busy painting the vessel. Listed her over to starboard this morning to clean the water line. Fine, clear weather with S.S.E. winds.

November 2: This morning Beck, King, Williams and myself, taking the small skiff, started westward along the coast from Turtle Cove to pick out some landing places and look for tortoises. We pulled down the coast about seven miles and beached the skiff on a fine sand beach, back of which was a lagoon surrounded by a dense growth of trees. A few wild cattle were about the lagoon, but did not show any fear

1905

or pay much attention to us. About half a mile inland we found five tortoises, one of which we skinned and carried to the beach, and the others we lashed to poles and carried out alive, a good, hard job. We launched our skiff into shallow water and got all the tortoises into it; then, with Williams and myself at the oars and Beck at the steering oar, started to pull outside the breaker line. With four men and five tortoises in a 14-foot skiff, there was very little freeboard left. Crossing the breaker line, we shipped a sea which very nearly swamped us. King got busy bailing the skiff out and we got safely beyond the breakers. It took us three hours to get back to the schooner. Arriving there at 6:20 P. M., we immediately shifted into dry clothing, as we got a good soaking getting through the surf. Weather clear to partly cloudy.

November 3: Landing parties ashore working about the vicinity of Turtle Cove. Went up the road leading to Santo Tomas again and enjoyed another feast of watermelons given to us by the native in charge of the garden. On arrival at the beach after our day's hunt, we were presented with a chicken and another melon. Nelson brought both skiffs in and we towed one full of water breakers back to the schooner. We found it quite warm about the lower levels, but could see the clouds and mist above on the mountain about the vicinity of Santo Tomas. Nelson busy during the day taking on water. Took on some atoyas today. These are a sort of coarse potato with rather a sweet taste and take the place of the potatoes long since used up. Mosquitos rather troublesome during the night. Cloudy during the day with light southerly winds.

November 4: All hands up at 6:30 A. M. Took skiffs on board and weighed anchor, setting sail for Indefatigable Island. Beat out against a very light southerly wind and did not get out of the channel between south Albemarle and Brattle islands till 1:00 P. M. Nelson busy repairing and painting boats. King and I built a tortoise pen on deck between the main hatch and the foremast, putting several tortoises in it to leave them to skin at odd times. All hands busy working with the specimens secured on Albemarle. At 8:00 P. M. we were about five miles off the west coast of Indefatigable and hauled

1905

the vessel on the wind for the night. Many shearwaters and petrels flying about the schooner. Fine, clear night.

November 5: At 4:00 A. M. Barrington Island bore E.S.E., distant about two miles. We tacked ship and stood in towards Indefatigable Island with a light S.S.W. wind. Weather foggy at times. At 10:00 A. M. we made up to the anchorage, a small bay on the south coast to the westward of Puerta de la Aguada. On nearing the spot where we were going to let go the anchor, we struck on a submerged reef just about the middle of the bay. No damage done and we hauled the schooner off with the kedge, letting go anchor in two and a half fathoms of water with fine, sandy bottom. We found that at low tide the top of the reef we had struck was just exposed above water. We named this bay *Academy Bay*, after the schooner, and it is now shown as such on the Hydrographic Office charts. From our anchorage, the center of Barrington Island bears E. by S. $\frac{1}{4}$ S. magnetic and the highest peak on Indefatigable N. by W. $\frac{1}{4}$ W. After making ship ready for port, we made a survey of the bay, finding just back of a small sand beach at the head of it a hole of "fresh" water. It is possible to drink this water without getting sick and it can be used in an emergency for watering ship. However, it is not to be recommended except as a last resort. Close by the water-hole, we found the remains of a grass hut, which, we afterwards found out at Vilamil, was used by a negro who had been marooned on the island by Manuel Cobos, the owner of the plantation on Chatham. We saw this man at Vilamil and he told us of being on the island for a whole year, living on raw tortoise meat and what shellfish he could gather. He was discovered by a passing vessel and taken to Vilamil. Several nice lagoons at the end of the bay abounded in fish, crayfish and oysters clinging to the mangroves. Weather cloudy today with occasional showers.

November 6: Shore party landed after breakfast. King and I stayed on board to work on tortoises. Williams reports going inland with party and finding an old trail running through rough country overgrown with cacti and thorn bushes. This trail was lost about a mile or so inland, where a green zone began. This zone abounds in large trees, the

1905

cacti becoming scarce as the elevation increases. Further up the mountain, creepers and small ferns appeared, the latter growing on the moss-covered rocks. Orchids, one species of which has a pretty pink flower, also put in an appearance. At the lower edge of the green zone Beck found a large tortoise. The shore party returned at 5:30 and was picked up by Nelson in the sailboat. Rain clouds covered the top of the island most of the day and we had a few light showers on the coast during the morning.

November 7: All hands ashore collecting. Went inland with Beck, King and Williams, Beck and I taking provisions, water and blankets for camping over night. Shortly before noon we reached the tortoise Beck found yesterday and started skinning it. After lunch, Williams and King left for the beach with the tortoise, taking five hours to make the trip. Beck and I went further inland looking for tortoises and camped over night in the green belt. It was cool enough to need blankets during the night. There were so many rats running about that we had to tie our provisions up in the trees with ropeyarns. We found in the morning that they had been gnawing on the handles of our skinning knives, which were well soaked with tortoise fat.

November 8: King returned to our camp this morning and, with his assistance, we started to skin and pack out three tortoises which Beck had found. Williams, Ochsner, Stewart, Gifford and Nelson, with three-days' provisions, started up country to try and make the summit of the island. Each man carried, besides provisions and blankets, a canteen and a gallon molasses tin full of water. They followed the regular trail that we packed the tortoises out on and reached the upper edge of the cactus belt where orchids and ferns put in an appearance. The ground became damper and the soil thicker as they ascended. Large trees were much in evidence, with a heavy growth of vines, creepers, and succulent vegetation. A little above this belt the undergrowth became rank and higher, the morning-glory vines causing much difficulty and it became necessary to cut a trail every inch of the way. At 3:00 P. M. camp was pitched and a little place cleared to build a fire, a rather difficult manoeuvre in such a country. After a supper

1905

of beans, coffee and canned fruit, some collecting was done, and Williams caught some beetles and a sphinx moth. Several bats were seen and some owls heard. Ants and mosquitos made sleeping rather impossible. To make things more interesting, it began raining at dark and a tarpaulin was rigged to keep bedding as dry as possible and to catch rain water for the canteens.

November 9: Beck still camped in the tortoise country, while I was helping to pack out the tortoises King and I had skinned. The mountain climbers still inland. Williams reports, after the first night out, all hands arose early. Stewart and Ochsner started back over the trail, while the rest of the party continued up the mountain. The country they now traversed is fairly level, but vegetation exceedingly thick, even worse than that of Cocos Island, if such could be possible. Nettles became very thick and troublesome and the undergrowth reached seven or eight feet in height. Several showers passed over the climbers during the day and they all got thoroughly drenched. The ascent was very gradual and slow, about four and a half hours for two miles according to the reckoning. Just before noon a halt was made under a grove of trees and the party decided to retrace their steps, as provisions were getting low and progress too slow and difficult. Gifford collected some rails and small land birds en route, also three rats. Williams collected a bat he found sleeping on some vines. The party camped at the same place as the previous night. Rain started falling at supper time and a small bottle of alcohol Williams had for collecting beetles was poured on the fire to keep it going so they were able to cook supper and have a camp fire during the night. Parker reported that during the day the vessel swung on her anchor chain and touched bottom at low tide. Shock not severe, but a little more so than when we struck bottom coming to anchor. The anchor was lifted off the bottom and the schooner hauled a little further out with the kedge. Weather cloudy with light showers today.

November 10: The mountain climbers broke camp at 6:30 A. M. and headed for the beach, collecting as they proceeded down the trail. All hands were thoroughly drenched by passing showers, which made traveling rather uncomfortable.

1905

Williams and Nelson developed sore feet to make things more interesting. The party reached shore at 12:30 P. M., pretty well tired out. Rest of the ship's company ashore packing out tortoises, a long, hard job at this particular place, as they are found quite a distance inland and the country is very rough. Occasional fine rains and southerly winds during the day.

November 11: All hands, with the exception of Gifford, Nelson and myself, went ashore to pack out a tortoise Beck found yesterday. I stayed on board to get the tortoises already skinned in the pickle tanks and clear up some of the previous catch. The shore party did not get back to the landing till 5:00 P. M. and had one of the largest tortoises taken so far. Cloudy all day with southerly winds.

November 12: Sunday. All hands enjoying a day of rest after a hard week of tortoise packing. Fishing over the side and repairing shoes indulged in by some. King and Williams went about one of the lagoons at the head of the bay and gathered some shells. Gifford ashore taking photographs. Weather cloudy and somewhat sultry today.

November 13: Williams and Gifford set out for the high country with provisions and gear to camp over night, Williams taking a reflector lamp for collecting at night, but not meeting with much success. King, Beck and myself camped in the tortoise country below, where three more tortoises were staked out ready to skin. Fine, clear weather with southerly winds.

November 14: Still ashore with Beck and King skinning and packing out tortoises. While King and I were coming down the trail with our pack, we were overtaken by Williams and Gifford on their way down from the green zone. Williams gave us a lift and reported finding a small tortoise just above the cactus belt. This is the farthest up the mountain we found any. At the beach we met Stewart and Hunter, who had started down ahead of us with another tortoise. Beck still camped inland searching for more tortoises. Williams reported seeing a hawk capture and eat a large centipede. Nelson finished filling water tanks today. Fine, clear weather with southerly winds.

1905

November 15: Went up with Williams to skin and pack out the small tortoise found yesterday. Reached the tortoise by eleven o'clock and had it skinned out by two. Being a small tortoise, it was easy packing and we reached the landing about five o'clock. Here we met Stewart, Beck and Ochsner, who had packed out another tortoise. Weather during the day exceptionally fine with light southeast winds. Mosquitos rather troublesome at night.

November 16: Most of the shore party collecting around the landing place. Beck, King and Hunter went up country to pack out a small tortoise, the fifteenth and last one taken on this visit to Academy Bay. Nelson went out in the ship's boat to visit a big rock off the main island, where he found a great number of sea-lions and sea iguanas. All hands returned on board for supper at 6:30 P. M. Fine weather with southeast winds.

November 17: All hands turned out early. At 6:30 A. M. set sails and weighed anchor. Tried to beat out from the anchorage, but the wind was too light and we could make no headway. At 8:30 A. M. we dropped anchor under foot and waited till 10:00 A. M., when the wind freshened up we beat out of Academy Bay, getting clear at 11:30. Set course around the island in the direction of Gordon Rocks. Wind freshened in the afternoon and we had a fine sailing breeze. At 4:30 P. M. we dropped anchor in 15 fathoms of water in a little cove on the northeast side of Indefatigable. Found a very strong current running and schooner riding to a taut chain. From this anchorage, the island appears to be very barren and the shore line is marked by several steep cliffs, extending to the water's edge. Numbers of turtles and sharks about the schooner. Lots of shoe repairing going on after our tortoise packing during the past few days. Sky overcast and a cool wind blowing this evening.

November 18: Beck went inland several miles to examine the country and look into the possibility of reaching the top from this anchorage. He found the country very rough and a long, gradual slope up to the wooded portions of the island. Prospects of reaching the top from this side did not look good, so no attempt was made. The lower country was found

1905

to be extremely desolate and covered with cacti and dried grass. Remnants of land iguana burrows were found, but the burrows were long since deserted. Ochsner found some good fossil collecting in the cliffs close to the anchorage. Strong southerly winds all day, the schooner at times dragging the anchor and making our navigator quite ill at ease.

November 19: All hands taking a day of rest. Nelson and Ochsner went fishing in the sailboat, catching eleven big barracuda, the largest about two feet long and weighing about twelve pounds. Gifford went ashore to take some photographs of fossils embedded in the cliffs. Williams had the shark hook overboard and caught one shark about seven feet long. Strong S.S.E. winds all day.

November 20: All hands ashore collecting until eleven o'clock. Nelson and King gathered some driftwood and brought it on board for the galley. 11:30 A. M. hoisted sails and weighed anchor. Hard work getting the anchor off the bottom. It took us about an hour to get the 30 fathoms of chain in. Set course to pass around the north end of North Seymour Island. Sailing wing and wing and making about seven knots. Early in the afternoon we rounded the end of North Seymour with fine sailing breeze. Breeze then became variable and at times the schooner was almost becalmed. At 4:30 P. M. we let go anchor in a large shallow bay on the southwest side of South Seymour Island in six fathoms of water. Fine, sandy bottom and good holding ground. Went ashore with Beck and Ochsner. Beck shot a couple of goats for fresh meat and Ochsner and I caught a large turtle on the beach. We tried to catch a second one, but it was too close to the water, and, when we grabbed it by the hind flippers as it made for the surf, it gave us a fine bath and some good, hard slaps with its flippers. Fine weather during the day with southeast winds.

November 21: All hands, with the exception of Beck, who stayed aboard to skin birds, ashore collecting. Found land iguanas abundant and scattered all about the island. Collected several of these, putting them in sacks and packing them down to the landing place. Goats were found to be plentiful and not so wild as those on Barrington Island. Just to the northwest

1905

of our anchorage was a fine lagoon, separated from the ocean by a long sand beach on which the surf broke furiously.⁵ Curlews, turnstones and ducks were found about the lagoon. Land birds seemed to be scarcer than on the other islands we had visited so far. Seymour is a low, flat island covered with lava flows, the whole ground color being a brick red. Nelson beached one of the skiffs and repaired and painted the bottom. Fine weather with southeast winds during the day.

November 22: King and I stayed on board to scrape and paint tubs used for the salt and alum bath to soak tortoises in. Rest of party ashore, doing general collecting. Williams and Beck went to the south end of the island, where there is a narrow and shallow strait separating Seymour from Indefatigable. They brought back some goat meat and two snakes. Late in the afternoon another shore party landed, Nelson and King to hunt goats and the rest of the party to bring back the big skiff, which had been left bottom up on the beach for the paint to dry. Nelson and King returned just before supper with three goats. After supper, returned to the beach with Hunter, Ochsner, Williams and Gifford. Hunter caught seven rats during the evening and Williams quite a collection of beetles and moths. All hands returned to the schooner at 10:00 P. M. Strong southeast winds during most of the day.

November 23: 6:15 A. M. weighed anchor and set course for Daphne Island, a small island to the westward of Seymour, forming an almost perfect crater some 250 feet in height. At 8:00 A. M. Nelson landed the shore party on the south side, the only place that we found accessible. He stood by with the skiff, while the schooner beat to windward of the island. Overhanging ledges seemed to extend around most of the lee side of the island, making it impossible to get up the side. The interior of the crater was found to have a fine floor of white sand about on the same level as the sea. It is almost bare with the exception of a small growth of cactus around its edges. On the floor of the crater was quite a large colony of boobies, and, among the rocks at the top of the rim, many tropic-birds were found nesting. While everybody was busy

⁵ When the writer visited South Seymour in December, 1927, on board of Capt. G. Allan Hancock's yacht *Oatca*, this lagoon had entirely disappeared.

1905

working about the island, Hunter, who happened to be on the rim of the crater, saw the skiff drifting out to sea with nobody in it. He immediately sounded the alarm and, while all hands were making for the landing place, Hunter and I went down towards the spot opposite to where we saw the skiff. We hailed Nelson and he answered back, saying that the skiff had got away from him while he was up on the rocks gathering some shells and he could not get up on the island on account of the overhanging ledge. We informed him that all hands were making for the landing and that we would hail the schooner and pick him up. Circling around to the landing place and finding all the party mustered, we fired off our guns and waved our hats to attract the attention of the schooner as she sailed by. Ochsner and White put off in the small skiff and picked us up. On returning to the schooner and landing some of the party, Gifford, Hunter and I went to pick up Nelson. We found him on a ledge of rock, where he was blocked from going in any direction. He made a dive off into the water and we backed in and picked him up. Hurrying back to the schooner, we got aboard and then ran down before the wind to pick up the lost skiff, which, in the meantime, had drifted far to leeward. As we approached it, a swell suddenly caught it just right, turning it turtle, the oars falling out and floating away. Nelson, Ochsner and Williams put off in the sailboat, which we had towing astern, to rescue the oars and the skiff. After gathering up the oars, the skiff was righted and bailed out. Nelson in the skiff and Ochsner and Williams in the sailboat, started to pull back for the schooner. Our navigator, trying some fancy "seamanship," attempted to pick up the painter of the sailboat while running before the wind. As a consequence the main boom tackle fouled the mast of the boat and swamped it, throwing the occupants into the water. Nelson, coming up close behind in the skiff, rescued them. The sacks of sand used for ballast in the sailboat were dumped overboard and the boat bailed out. The schooner in the meantime was hove to and both boats pulled up and were taken in tow. Course was shaped for Daphne Island and we again landed at 2:30 P. M. The party was called off at 4:30 and the schooner was headed for the coast of Indefatigable, where

1905

we dropped anchor off the north side in seven fathoms of water. Fine weather during the day with fresh southeast winds.

November 24: Landed with Stewart opposite our anchorage, while Beck, Nelson, Ochsner and King continued down the coast to the eastward, entering a large lagoon extending a half mile or so inland. Many turtles, mantas and sharks were seen in the shallow waters, one of the latter coming towards Nelson while he was in the water gathering shells. King struck the shark with an oar and sent it heading full speed in the opposite direction. At noon I met Williams coming down the beach and stopped and had lunch with him. Continuing on our way back to the landing place, he killed an oyster catcher with a stone and turned it over to the ornithologists. Nelson came in with the skiff and picked up the shore party. All hands aboard for supper at 6:30. Fine, calm and clear night.

November 25: Stayed aboard with King and skinned turtles. Rest of the party ashore opposite anchorage, except Williams, Nelson and Ochsner, who went down to the lagoon collecting shells and turtles. They reported the lagoon to be a wonderful place for turtles, shells, fish, sea urchins, oysters and various forms of marine life. The party brought back quantities of shells and three turtles. Owing to a choppy sea and head wind, it was a long, hard pull back to the schooner. Beck returned on board with three dozen doves for making a dove pie. Weather warm and partly cloudy today. Mosquitoes put in an appearance this evening.

November 26: All hands resting and doing odd jobs about ship. Hair cutting and beard trimming indulged in before breakfast. A party going inland getting gear in shape in order to get an early start in the morning. Roast doves for dinner make a welcome addition to the bill of fare. Light southerly winds during the morning, shifting to northerly in the afternoon.

November 27: Stayed on board with King and skinned turtles. Hunter, Ochsner and Williams, loaded down with provisions and water, made for the interior prepared to camp for two or three days. They found it difficult to push through

1905

the dense brush and over the lava flows and progress was anything but fast. Late in the afternoon they made camp and had some doves, which they had killed on the way inland, for supper. Four owls, attracted by the light of the camp fire, were shot and a few moths and beetles collected. Party on ship working at various localities. Two went to Daphne Island in the sailboat after birds and two went back to the lagoon, bringing back four more turtles. Fine weather with light, variable winds during the day.

November 28: Stayed on board all day and skinned turtles. Williams and party still up country. They reached an altitude of 1,060 feet above sea level. Warm weather and rough country made further progress impossible, as the water supply was getting too low for comfort. Party started back at noon time. At 5:00 P. M. a fire on the beach announced their arrival and I went in with the skiff to pick them up. Their water supply barely lasted them to the beach. Another visit was made to the lagoon today and two more turtles brought back. We have quite a collection of them on deck now. Fine, clear weather all day with light, variable winds.

November 29: Nelson and Gifford shoved off in the sailboat intending to visit Daphne Island. The wind failed them and course was changed for South Seymour. They collected some birds and three goats for fresh meat. Leaving the island at 4:00 P. M. under a variable breeze, the schooner was reached at 6:30. Beck, Ochsner and Williams went back to the lagoon shooting some petrels on the way. They pulled the skiff into an arm of the lagoon and hooked seven turtles with a gaff. Party returned loaded down with turtles and shells. I stayed on board all day with King and skinned turtles. Fine, clear weather with variable winds.

November 30: Thanksgiving Day! All hands turned out at 6:00 A. M. for 6:30 breakfast, after which we all went ashore to hunt doves for our Thanksgiving dinner. By nine o'clock we mustered at the landing place with 96 doves between us. We plucked and cleaned them on the beach, bringing them on board for the cook, who gave the dishpan an extra good cleaning and used it to bake a dove pie in. Dove and cocoanut pie dinner at 2:00 P. M. After dinner Wil-

1905

liams put the shark hook overboard and caught a shark. It made quite a fight, but was pulled to the surface and despatched with a bullet. Pulling it in on deck, it was found to measure nine feet, to have transverse dark stripes on the sides and a wonderful set of sharp teeth. A goat hide and a few balloon fish were found in the stomach. Several other large sharks were seen swimming about the schooner. After a late supper of turtle egg cake, cold goat and fruit, Ochsner gave us a concert on his flute and all hands turned in. Variable winds and calms during the day.

December 1: All hands up for 6:30 breakfast. Hoisted sails and shortened chain to 15 fathoms to await enough breeze to get under way. At 8:00 A. M., under a light breeze, we weighed anchor and shaped course for Duncan Island. Light winds during the morning, but in the afternoon a good sailing breeze sprang up and at 6:00 P. M. we made up to the island. The skiff was put out and soundings taken to buoy an anchorage. Sandy bottom was found close in to shore, so the anchorage was buoyed and the schooner, sailing up to the buoy and coming up into the wind, dropped anchor on the northeast side of the island in eight and a half fathoms of water. Rather cool with strong breeze this evening.

December 2: Stayed on board with King and skinned two turtles, and also a tortoise brought down from the crater by Hunter. Rest of the party ashore collecting. Williams went to the top of the island, taking about two hours for the trip. The sides of the island are very steep, rough, and covered with a dense growth of thorn bushes and cactus, which makes traveling quite difficult. There is no real green zone at the top of the island, but small ferns, moss, and a couple of species of orchids were found growing among the rocks. On the southwest slopes of the island, where most of the tortoises were found, the brush is covered by a heavy growth of lichen, on which they feed. Beck returned late in the afternoon, reporting that he had found 12 tortoises. Strong southeast winds during the day.

December 3: All hands keeping Sabbath. Nelson did some fishing without much success. Rest of party mending clothes,

1905

cutting hair, etc. Strong winds from the southeast throughout the day.

December 4: Still very windy. Williams stayed on board and helped King and myself skin turtles. Rest of party ashore collecting. Hunter, Ochsner and Stewart brought back a small tortoise apiece. A large school of porpoises passed close to the schooner this afternoon. Weather rather cool and sweaters were worn while working on deck. Beck and Nelson camped ashore this evening. Strong southerly winds throughout the day.

December 5: Stayed on board this morning and skinned turtles. After lunch Williams and I started up the trail loaded down with provisions and gear for camping out. Reaching a small valley near the top of the island, where Beck and Nelson had established a camp, we made our beds out of a tall grass that grew abundantly in the vicinity and prepared for an extended stay. We rigged up a tarpaulin to shelter us from the wind, and, with an abundance of grass for a bed, we had quite a comfortable campsite. The shore party coming in each day brought us water and what food we needed. Nelson acted as camp cook and was a first class one. A plentiful supply of doves was always at hand and we all agreed that we had a first class camp. No mosquitoes here and not many rats about camp at night. The weather is nice and cool and we all sleep under blankets. Beck and Nelson skinning and packing out tortoises today. A meeting place was selected at a point where the trail descended down the side of the island and the tortoises were brought to this point so that the shore party going back to the schooner could pick them up, leaving Beck, Williams, Nelson and myself in camp hunting and skinning.

December 6: In camp on Duncan Island skinning and packing tortoises. We have several staked out about the valley and adjacent hillsides. They are quite common and we have no difficulty in running across them just as fast as we can skin them. We find that they are more abundant on the southern slopes of the island, where there is a heavy growth of moss covering the underbrush. Fine weather, but a little windy at night outside the shelter of our tarpaulin.

1905

December 7: Still in camp on Duncan, sending down about four or five tortoises a day. Weather continues fine. This afternoon we caught a hawk and made it fast with a rope-yarn to a small dead tree alongside our camp fire. We kept it there during our stay in camp and fed it on tortoise meat every day.

December 8: Today the shore party packed out one large male tortoise alive. One or two skinned and one small live tortoise to a man is the plan here, as the tortoises are usually small and packing is much easier by this method. A plentiful supply of doves every night for supper. Weather still continues fine.

December 9. Williams and I went over on the south slope of the island to skin a tortoise Beck had staked out, but, not finding it, we skinned and carried out another. Nelson also skinned out one and packed it up to our meeting point, finding three or four more on the way. In order to take a day of rest and spend Sunday on the schooner, we all left camp at four o'clock, Beck carrying three small skinned tortoises in a sack, Nelson a medium sized tortoise alive, Williams a small live one, and myself a large skinned one. We got to the landing place about 5:30 and all took a wash for the first time in five days. Beck shot a lot of doves on the way down for our Sunday dinner. 20 tortoises were packed out during the week. We have 12 more staked out in various places. Weather still fine and clear.

December 10: All hands aboard ship keeping the Sabbath. Williams went fishing over the side and caught 20 or more fish of various kinds. Doves and cocoanut pie for Sunday dinner. Weather fine and clear with a little less wind than usual.

December 11: With Beck, Nelson and Williams, went back to camp again to start skinning tortoises. We kept at work till sunset skinning and packing. Nelson is a fine camp cook and we enjoy our dove suppers every night. Full moon to-night with fine, clear weather.

December 12: Skinned and packed tortoises all day. About the middle of the night Williams and I awoke to find rain

1905

coming down on us. We posthaste got the tarpaulin unriggered and spread over us, then tried to get to sleep as best we could.

December 13: Turned out rather miserable and wet this morning and took a brisk walk down the valley to try and warm up. Weather cleared early and we took off our clothes and hung them up to dry. The rain brought the tortoises out of the thick brush and we saw many walking about feeding on the wet moss and drinking from water holes in the lava.

December 14: Two of the boys from the schooner came in today and helped skin tortoises. Both returned in the afternoon each with a tortoise. The rest of us still keeping up the camp so as to save time going back and forth. Weather improved somewhat today and it is about back to normal.

December 15: Hunter came up to camp today and helped with the tortoises. Rest of the party ashore collecting and helping to carry down the day's kill. The hawk we have for a camp mascot gets a fill of meat every night and probably never lived so high before in its life.

December 16: 18 tortoises packed out today, making a total of 51 for the week. We broke camp this afternoon and packed all the gear down to the landing. We cut the hawk adrift as we left the camp and now it will have to work for a living. The deck of the schooner is now covered with live tortoises and the pickle tubs are full. Took another wash this evening, the first for a week. It was strictly against camp rules to use water for anything except drinking purposes.

December 17: All hands keeping the Sabbath after a hard week. Williams went fishing over the side and caught nine big barcalau, some of which we had for supper. One small shark also hooked. Weather clear with fresh southerly winds.

December 18: All hands up for six o'clock breakfast. Hoisted sails and weighed anchor, setting course for Jervis Island. We arrived off the northeast side at 1:20 P. M., letting go anchor in 7 fathoms of water. This afternoon helped Nelson and Williams break out some provisions for stowing in the lazaret. We also stowed about 45 turtles and tortoises away in the hold. Rest of party ashore collecting. Hunter reported seeing some tortoise tracks. Strong winds from the S.S.W. this afternoon.

1905

December 19: Beck, Ochsner, Gifford and Nelson put off in the sailboat to visit James Island, the rest of the party landing on Jervis. I went up to the top of the island with Williams, collecting a snake and some lizards on the way. Close to our anchorage we found a lagoon with several ducks on it and a cave full of sea-lions. Supper was delayed this evening to await the arrival of the boat party. At 7:45 there was no sign of the boat and we put up the anchor light so that they could locate the schooner. At 8:40 they returned, after bucking a head wind all the way across the channel. They brought back two turtles and a sea iguana. The boat was slightly damaged getting out of a lagoon, the keel striking on a submerged reef. Party reported seeing many wild donkeys on the higher slopes of the island and, at the landing place, a large lagoon full of turtles. Weather partly cloudy with fresh southerly winds.

December 20: Nelson and I beached the sailboat opposite our anchorage and repaired the keel. We had repairs completed about 11:00 o'clock and sailed for the turtle lagoon on James Island. Rest of party ashore on Jervis. Beck found the tortoise supposedly left here by Baur in 1892. It was found at the head of a slide of cinders about 500 feet up the hillside. In the afternoon the shore party brought some lashings ashore and pulled the tortoise down the slide, bringing it on board alive. Nelson and I made the run over to James in about an hour and a half, collected four turtles, one of which is about the largest yet taken, and started back for the schooner, reaching it shortly after 6:00 P. M. Weather cloudy with fresh southerly winds.

December 21: Shore party returned to the schooner at 11:30 A. M. and we weighed anchor, setting sail for James Island. We made James Bay at 4:30 P. M. and anchored off a long beach of red sand in nine fathoms of water. We found later on that there was a very strong undertow here and that it was sometimes difficult to get on and off the beach owing to the heavy surf. A large recent lava flow is in sight just to the south of our anchorage. The island appears to be well wooded with a fine green zone

1905

at the higher elevations. Fine weather with fresh southerly winds during the day.

December 22: Stayed on board all day and skinned turtles. Rest of the party ashore collecting about the vicinity of the bay. Hunter shot 12 ducks on a lagoon just back of the beach. Nelson and Ochsner went up towards the top of the island in search of a pig, but only saw one, which they did not get a shot at. Williams and Gifford went well up into the green zone, finding plenty of large trees and the undergrowth not so thick as that of Indefatigable. This morning, while landing the shore party, took one large turtle off the beach. Fresh southerly winds during the afternoon.

December 23: Stayed on board skinning turtles. Nelson and Ochsner ashore again after pigs and this time got two. King and Beck went out in the skiff shooting petrels. Several large sharks were seen about the schooner feeding on the turtle meat thrown overboard. Fine day with strong southerly winds

December 24. All hands keeping the Sabbath and mending clothes, shoes, etc. No landing party ashore today. Weather remains the same.

December 25: Christmas Day!! 181 days out from San Francisco. Late breakfast this morning and another holiday. The cook made us plumduff for dinner. Weather about as usual, but a little less wind. This evening it is almost calm.

December 26: With Beck, Williams, Gifford and King, took the big skiff and pulled around towards the north end of the island. Beck and Williams took three days' water and provisions, intending to go inland on a tortoise hunt. We pulled down the coast for some miles and beached the skiff, going through quite a heavy surf. King went inland a couple of miles with Beck and Williams, carrying a can of water, which was cached for the return trip of the tortoise hunters. He then joined Gifford and myself and hunted about the lowlands in the vicinity of our landing place. We found the remains of an old camp just back of the beach, no doubt one used by former tortoise hunters. Carved in the rocks close by the landing, we saw some inscriptions giving the names of

1905

some of the old New Bedford whalers, the names of the captain and mate, the number of days they were out, and the number of barrels of oil obtained. My note book in which I copied down these data was unfortunately lost, as our skiff was swamped a couple of times getting through the surf. Williams and Beck, after leaving King, proceeded inland through heavy brush and cactus, making camp at 5:00 P. M. at an elevation of about 1,900 feet. There are plenty of trees at this elevation, but no green zone, it being much higher up on this side of the island. Williams reports that, after a sleepless night, in which they saw many rats running about the brush, they ate breakfast and traveled another mile or more to the green zone, camping at the foot of two large trees.

December 27: Stayed on board all day skinning tortoises. Rest of party collecting about the vicinity of the bay. Williams and Beck still camped inland in the green zone. They found a couple of little springs which had long since dried out. Beck took a long tramp around in a northerly direction and found the remains of an old tortoise shell, but no live tortoises nor any signs of them. Several pigs and burros were seen, the latter not especially wild. They make fairly good trails through the brush, which makes traveling somewhat easier at times. Hunter and Ochsner went up country to camp over night. Weather fine with fresh southerly winds.

December 28: Stayed on board all day skinning tortoises. The rest of the party, with the exception of Beck and Williams, who are still camped up in the green zone, working about the vicinity of James Bay. Beck started out this morning in search of tortoises, leaving Williams collecting around the vicinity of the camp. Beck returned about noon time after an unsuccessful search and they both headed back for the coast, reaching the landing place about five o'clock. Nelson put off in the skiff and picked up everybody ashore, getting back to the schooner at 6:00 o'clock. Wind somewhat variable today, hauling from S. to NW. and in the evening hauling to S. again.

December 29: Beck started for the south side of the island to hunt for tortoises. Williams and I worked about the vicinity of the bay and collected much excellent material. Late

1905

in the afternoon Nelson and Hunter came ashore with the intention of making camp on the shores of a lagoon back of the beach and get a shot at a pig. Fine, calm evening tonight.

December 30: Went ashore with Williams to visit the camp by the lagoon. The hunters did not succeed in shooting any pigs, nor did they even see or hear any. However, they told us that during the night they were nearly eaten alive by mosquitoes. Hunter shot some ducks and a flamingo. Beck returned this afternoon, having camped out overnight, and reported that he had found no signs of tortoise. All hands aboard for supper this evening. Strong breeze from the southward at sunset.

December 31: All hands keeping the Sabbath. Beck threw a few bird bodies over the side and they attracted a large school of balloon fish, Williams catching several with a dipnet. Lots of shoe repairing and mending of clothes going on today. With Ochsner, Williams, Hunter and King, I stayed up to see the new year in. We ushered it in with the ship's foghorn and turned out all hands and the cook. Weather conditions about the same.

1906

January 1: New Year's Day and the 188th day of the voyage!! Late breakfast today and no shore party landed. Some of the boys making preparations to go inland tomorrow and camp over night. The cook made us pumpkin pie for supper. Weather cloudy with strong southerly winds.

January 2: All hands, with the exception of White, Parker and myself, landed after breakfast, carrying water and provisions for three days. I landed one boat load and pulled back to the schooner to work on tortoises. The party started for the top of the island, making slow progress at first on account of the heavy packs and thick brush. They halted at the one thousand-foot level for lunch and rest. Proceeding upwards, the brush became thicker and the vines and overhanging branches made progress more difficult. Late in the afternoon some burro trails were followed, which made traveling easier, and at 4:30 P. M. the party pitched camp at the edge of the green zone on a small grassy slope surrounded

1906

by some fair sized trees. A shelter was erected as protection against the rain, which passed over in showers. Mosquitoes were found to be somewhat troublesome during the night. Weather on the coast fine during the day with some fog at night.

January 3: Stayed on board skinning tortoises. Party in camp were all up early. Ochsner, Williams, Hunter and Gifford made the top of the island, which they found, according to the aneroid, to be 2,750 feet above sea level. On the journey up, they had to make a halt for the fog to thin out, but on reaching the top the weather cleared and they had an excellent view. The masts of the schooner were visible and Bindloe and Abingdon islands could be seen off to the northeastward. The trees on top of the island were found to be somewhat stunted and had their trunks enveloped in ferns and moss. Groves of tree ferns also helped to cap the summit. The party ate lunch on top and, returning to camp, found Nelson with a couple of pigs he had killed while out hunting. Stewart and King started down from camp, collecting on the way. Swinging to the southward, they got out of the brushy country and came down some recent lava flows, which made passable walking at times. Tonight the mountain is fine and clear and plainly visible from the schooner.

January 4: Stayed on board and skinned tortoises. Party camped up the mountain started down this morning. Nelson shot four pigs on the way, the younger ones not being such bad eating. About five o'clock sighted the party on the beach and went in with the skiff to pick them up. While the boat was being loaded, caught two turtles and brought them on board. Fine weather with unsteady winds during the day.

January 5: All hands up for early breakfast. At 7:00 A. M. weighed anchor and set sail for Indefatigable Island. Very light southerly winds during the morning and light unsteady winds during the afternoon. Hoisted the large skiff in on deck for overhauling and repairs. King and myself busy during the day skinning tortoises at odd times. Nelson broke out the hawser and kedge, so in case we get to drifting we can try and pick up bottom somewhere. Beck went out in the small skiff to shoot some birds and brought back about

1906

40. Great numbers of terns and shearwaters about the schooner. Tonight we had some James Island pig for supper. At midnight we were about five miles from James Bay. Fine weather with light airs and calms during the day.

January 6: Wind freshened up a little during the morning and we worked up towards Nameless Island. About 6:00 P. M. we passed in between Jervis and Duncan islands. Ornithologists busy all day skinning birds and King and I were working on turtles. In the evening the wind fell light again and we made no progress, there being a current setting us to the northward. Weather fine and clear during the day.

January 7: Opened with light airs from the S.S.E. The schooner was almost becalmed at times during the day. We made short tacks close on to the coast of Indefatigable and at 6:00 P. M. we were 3 miles southeast of Nameless Island. The wind falling light, we drifted back towards Nameless and at midnight we were within a few cable lengths of it. A great many sharks were about the schooner most of the day, no doubt attracted by the bird bodies being thrown overboard.

January 8: Wind still light with occasional spells of calm. Current setting us to the NW. and at noon the schooner was off the Crossman Islands, which bore by compass SW., distant 2 miles. Some fog during the morning, but weather cleared towards the afternoon. All hands busy standing watches and working with their specimens.

January 9: Opened with a light breeze from the SE. Later in the morning the breeze freshened somewhat and we got some steerage way. At noon we were about one mile off the coast of Indefatigable, the highest peak bearing N.N.E. In the evening the wind died down again, leaving us close to the Indefatigable coast and drifting to the northward.

January 10: Opened with occasional calms and light breezes from the SE. The schooner drifted back several miles, not being able to stem the current. At midnight the Crossman Islands bore W. by compass, distant 3 miles. Everybody taking advantage of this time at sea to pack up collections and straighten things up in general.

January 11: A fair sailing breeze during the night brought us up to the coast of Indefatigable, but, in the early morning,

1906

it died down and we started to drift again. At 8:30 A. M. we let go the kedge in 25 fathoms of water about a quarter of a mile off shore, the main peak of the island bearing N. 12 E. by compass. Beck, Hunter and myself went ashore, pulling the skiff into a small lagoon. We found old signs of tortoises and collected some of the largest sea iguanas we had yet seen, some being over four feet in length. We returned to the schooner before noon and, hoisting the kedge, beat up against a light wind towards Academy Bay, where at 7.00 P. M. we dropped anchor in three fathoms of water. The mosquitoes gave us a warm welcome this evening and kept us awake most of the night.

January 12. All hands ashore collecting and filling water breakers at the water hole. After breakfast Nelson left the schooner in the sailboat bound for South Albemarle to get a load of atoyas, as our stock is running low. He made Brattle Island towards evening and anchored under the lee of it for the night, starting at 2:00 o'clock in the morning for Vilamil, which he reached early in the afternoon. Light southerly winds and fine weather throughout the day.

January 13. Went inland with Beck in search of tortoises and found two, which we tied up for the morrow. The rest of the party collecting around the landing place and helping to water the schooner. Hawks are plentiful around the water-hole and Ochsner and Parker killed nine of them by knocking them down with sticks. This evening we burned a smudge fire in the cabin to get some relief from the mosquitoes. Fine, clear weather continues.

January 14: Late breakfast, today being Sunday. Went ashore with Williams and King to wash clothes at the water-hole. Beck went to a nearby lagoon to take some photographs and gathered some crayfish, which the cook made into a salad for supper. Hunter fumigated the cabin with cyanide and killed a number of bedbugs, flies and cockroaches, not to say anything of the mosquitoes. Some of the party mending shoes and making preparations for another trip inland. Weather somewhat warmer today.

January 15: Went inland with Beck and King to skin and carry out a tortoise. Ochsner, Gifford, Hunter and Williams

1906

started for the green zone prepared to stay over night. They pitched camp in the same spot as on their former visit. This afternoon Nelson left South Albemarle in the sailboat with a cargo of atoyas. He beat out to Brattle Island and anchored *under the lee of it for the night*. Beck, King and myself skinned out a large tortoise and packed it down to the coast, arriving there about 5:30.

January 16: Ochsner, Gifford, Hunter and Williams camped in the green zone trying to make the top of the island. They collected several rats, a barn owl and some rails. In the afternoon they pitched camp in the middle of the trail they were cutting and made a shelter of Canna leaves to keep them dry during the night. With the help of some kerosene, they started a fire to cook supper. Cooking is somewhat difficult, as the forest is kept continually wet by the clouds that cover the top of the island most of the time. After a supper of beans, coffee and canned fruit, all hands turned in early. It started raining before daybreak and, despite their shelter, all hands got thoroughly drenched. Beck, King and myself were up in the cactus belt skinning and packing out a tortoise. Nelson, in the sailboat, left Brattle Island at 7:00 A. M. and made for the southwest coast of Indefatigable, which he reached at 10:00 P. M. and anchored for the night. Fresh to moderate southerly winds and fine weather during the day.

January 17: Beck, King and myself started back for the cactus belt to skin and pack out another tortoise. We got back to the landing place with it about 5:00 o'clock. At 6:00 o'clock this morning Nelson started for the schooner and reached it early in the afternoon. He brought back 300 pounds of atoyas. We find these a very necessary addition to our stores, as they are the only fresh vegetable we can procure. The party up the mountain, after a wet and disagreeable night, found it impossible to make any headway against the jungle and started down the trail they had cut. On reaching dry country, a halt was made to prepare some coffee and flap-jacks, as cooking in the wet zone is next to impossible. They made camp for the night and were nearly eaten alive by mosquitoes. Weather about as usual, warm and sunny at the lower levels.

1906

January 18: After breakfast, started back for the cactus belt with Beck and King to pack out another tortoise. The party up the mountain started for the coast this morning, collecting as they came down the trail. They reported having reached an elevation of 1,100 feet, when the jungle became impassable, and it became necessary to cut trail all the time. The green zone extends considerably lower on the south side of the island. Nelson busy during the day watering ship. Fine weather still continues.

January 19: All hands, with the exception of Gifford and Nelson, went up to the cactus belt to skin and pack out two large tortoises Beck tied up yesterday. Nelson busy watering ship. About 9:00 o'clock we reached the tortoises and skinning operations began at once. We had them skinned out by noon and, after lunch, started for the coast, reaching the landing place about 5:00 o'clock. Weather fine with light southerly winds.

January 20: Went up to the cactus belt again with Beck, Nelson, Ochsner, Hunter and Williams to skin and pack out another tortoise. Got back to the landing place at 4:00 o'clock and all hands enjoyed a swim. Weather quite warm today and somewhat sultry. All hands aboard for supper this evening, and, being Saturday and the last day of tortoise packing for some time, we celebrated the event by having codfish balls and plumduff.

January 21: All hands keeping the Sabbath. Williams did some fishing over the side and a swimming party went over to the lagoon at the west side of the bay. Being Sunday, we had late supper this evening. For some unknown reason the mosquitoes were not so troublesome this evening, which is a great relief.

January 22: Beck, King, Williams and I went ashore to wash clothes at the waterhole, returning to the vessel at 10:30. Rest of party cleaning off the schooner's sides. At 11:00 A. M. hoisted all boats and weighed anchor. We beat out of Academy Bay against a light breeze and set course for Chatham Island. Light breeze from the S.S.E. during the day. At 8:00 P. M. Barrington Island bore by compass S. by W., distant eight miles.

1906

January 23: A fair breeze during the early morning brought us up under the lee side of Chatham Island. Worked vessel close in shore to get the benefit of the current. At noon Kicker Rock bore SW. by W., distant two miles. Had some rain this morning and we spread the awning to try and catch some rain for drinking water, as the Indefatigable water is none too good. On the higher parts of Chatham it appeared to be raining most of the day. At midnight Kicker Rock bore by compass SE. by E., distant two miles.

January 24: Opened with light winds from the southward, hauling to S.SE. and freshening up about 2:00 A. M. Steered SW. till 5:00 A. M., then tacked ship and stood inshore. At 8:00 A. M. Kicker Rock bore N.N.W., distant one mile. Somewhat hazy with light showers during the morning. Wind freshened from the southward about noon and we made short tacks along the coast towards Wreck Bay, which we reached at 4:45 P. M., letting go anchor in five fathoms of water. Light rains and cloudy weather during the afternoon. Ochsner and Gifford went ashore after supper to see about getting our mail. The plantation owner informed them that it would be brought down to us in the morning.

January 25: Raining this morning and it is impossible to do much work. Beck went up to the settlement to visit the plantation owner. Williams and I spent the morning collecting along the road to the hacienda, which is now quite muddy from the recent rains. The mail came down about noon and we spent the rest of the day reading letters and entertaining company. The Governor came aboard this evening for supper. Raining most of the day.

January 26: All hands ashore collecting. Williams and I went up the road to the hacienda. On the way we met several natives going down to see the schooner and bringing along bunches of bananas for us. Returned to the beach in time to board the schooner for supper, Beck and Williams staying on shore to have theirs with the plantation manager. Cloudy and threatening all day, but no rain. Light S.SE. winds.

January 27: All hands ashore collecting. Went with Williams to the higher levels of the island and found everything soaking wet and had very poor collecting. We therefore re-

1906

turned to the lower levels, collecting along the road on the way down to the coast. The Governor sent us some more bananas today. We now have about 14 bunches hung on the strongback of the after davits. Weather clearing somewhat today. Fresh S SE. winds.

January 28: All hands keeping the Sabbath. Most of us writing letters and entertaining company. One of the men we met on Charles Island hunting cattle came aboard to see us. A Barbados negro was given a hymn book, which he seemed to prize highly. Some more bananas brought aboard today. This afternoon Beck and Williams went ashore to see the plantation manager about settling for the anchor we had purchased from him and partly paid for. He was given some flour and soap, both of which articles are very much in demand. Beck bought some native coffee to take the place of the "coffee" in the ship's stores. The manager asked us to be very careful to see that no firearms got into the possession of the natives. Fine weather today with light S.S.E. winds.

January 29: All hands ashore collecting. Williams and I went to the top of the island. The summit is a symmetrical cone, covered with a heavy growth of club moss a foot or so in height. The plateau surrounding the cone is covered with beautiful green pastures and hedges of agave, the sides of the cone itself having many small tree ferns, which give it a somewhat tropical aspect. From the top, several small lakes are visible, and the country in general is excellent for the many cattle which could be seen scattered about the plateau. We found a remarkable absence of bird life and no reptiles at all. Gathering some land shells, which we found clinging to the moss, we started down towards the coast, arriving there at 5:00 o'clock. The natives brought us more bananas today and also some pineapples. Fine weather all day with fresh S.S.E. winds.

January 30. All hands turned out early and, after breakfast, got the vessel ready for sea. Beck and Williams went ashore to bring some supplies to the plantation manager and purchase some more coffee: 100 pounds for \$15 gold. Some barrel hoops to repair the tubs used for soaking tortoises were also purchased. On the return of the boat from shore, we

1906

hove short and were about to get under way when a sloop was sighted heading in, so we waited to see if she came from the mainland and had any mail for us. As she passed in, we hailed her and found out that she had come from Indefatigable and Seymour islands. On board could be seen a bunch of live goats, no doubt taken off of Seymour. Proceeding to break out the anchor, we sighted a native in a canoe paddling towards us for all he was worth, so the schooner was held close to the wind until he came alongside. He had two pineapples for us, presented with the compliments of the Governor. He no doubt was fully aware what would happen if he failed to deliver the pineapples, hence the burst of speed. Sky clouded over this afternoon and we had light S.E. winds. Sailing full and by, bound for Hood Island. Considerable swell running. Passed McGowans Reef at 3:00 P. M., 21 miles to windward. Tacked ship at 4:30 P. M. and made short tacks during the night.

January 31: Opened with fresh breeze from the S.E. At 6:00 A. M. Hood Island bore E. $1\frac{1}{2}$ S., distant eight miles. Worked the schooner up to the north side of the island, making short tacks close inshore. Found a very strong current running between Hood and Gardner islands. At 2:30 P. M. let go anchor in three fathoms of water in Gardner Bay. Cleared up decks and spread awning. Quite a ground swell and schooner rolls considerably. Shore party landed and Beck and Nelson went after goats for fresh meat. Williams and I went in at 5:00 o'clock and picked up the shore party. We shipped a couple of heavy seas getting off the beach, but no damage was done. Nelson got two goats and Beck one Chatham Island pineapples and Hood Island goats for supper. Wind fresh from the S.E. at nightfall.

February 1: Beck, King, Gifford, Williams and myself took the large skiff and pulled down to the albatross colony. It being impossible to beach the skiff here on account of the rocky coast, I landed the shore party and then pulled out and anchored the skiff to await the return of the hunters. No albatrosses were taken, but a number of tropic-birds, gulls and their eggs were collected. We pulled back to the schooner in a fairly heavy sea and then picked up the other shore party

1906

from opposite the anchorage. Goat meat every night for supper and occasional banana pies made from our Chatham Island bananas make everybody have a good appetite after some of the menus we have had. Nelson busy during the day oiling down the decks. Weather partly cloudy with SE. winds.

February 2: Ornithologists busy on board skinning sea-birds taken at the albatross colony yesterday. King stayed on board and skinned a turtle. Williams and I went inland towards the top of the island and found the country quite dry. We are always in hopes of picking up a tortoise and try to visit the greener parts of the island. Nelson ashore again after more goats. It is necessary to get fresh meat each day, as in this climate it will not keep any length of time. Fine, clear weather and southerly winds.

February 3: All hands, with the exception of Beck and Ochsner, landed on Gardner Island, the latter landing on Hood. Gardner is a very small island exactly the same type as Hood, but lacks the abundance of cacti. Williams and I spent the day on the island and found many interesting specimens. The remainder of the party left at noon. Beck returned from the top of Hood, having found some old tortoise bones and brought in a supply of doves for the galley. Ochsner brought in a couple of goats, so we are living high for the present. Nelson on board today oiling down decks. Fine, clear weather with SE. winds.

February 4: All hands keeping the Sabbath. Williams put the shark hook overboard this morning, but met with no success. Beck spent part of the day ashore taking photographs. Fine, clear weather with S SE. winds.

February 5: With Beck and Williams, again visited the albatross colony. Rest of shore party landed opposite the anchorage. Williams kept the boat this time and I landed, gathering in a couple of sacks full of sea iguanas and a small turtle found on the beach a little further down the coast. Beck collected a lot of seabirds and shot a couple of goats for the mess. We returned to the schooner early in the afternoon. Nelson finished oiling down decks. Weather partly cloudy with S. SE. winds.

1906

February 6: Again visited the albatross colony and held the skiff while the ornithologists were ashore collecting. Williams went to the top of the island and reported seeing many goats. Ornithologists collected a number of seabirds, but reported seeing no albatrosses. Some old eggs were the only signs of the colony at this date. Ochsner came aboard this afternoon with two goats for the mess. Several large sharks seen about the schooner today. Fine weather with SE. winds.

February 7: All hands turned out at 5:00 A. M. After coffee, weighed anchor and set sail for Freshwater Bay, Chatham Island. Light winds from the SE. during the morning, freshening towards noon. At 2:30 tacked ship about one mile SE. of Whale Rock and found we were not able to make the bay. At 4:00 P. M. shaped course for Bassa Point on the northwest side of the island, where we let go anchor at 7:00 P. M. in five and a half fathoms of water. Full moon and smooth sea at nightfall.

February 8. All hands ashore collecting. Williams and I went up to the thousand-foot level and found the country very rough and the brush too thick to get through in places. The ground had been soaked by recent rains. It started to rain early in the afternoon and continued till we reached the landing place, soaked to the skin. Nelson came in to pick us up and, as the sea was quite choppy, we shipped two or three getting off and got an additional soaking. Nelson busy during the day cleaning off seaweed from the waterline. Southerly winds with squalls and rain throughout the afternoon.

February 9: All hands up for early breakfast. At 7:00 A. M. weighed anchor and shaped our course for Sappho Cove, about four miles to the northwest. We had light winds and calms throughout the morning and did not reach the cove until 1:45 P. M., when we let go anchor in two fathoms of water. Here we found the sloop *Josephine Cobos* from the Chatham plantation at anchor. The crew is making a new rudder and cleaning off the sides. Beck, Hunter and Gifford went ashore and collected some birds and nests. Mosquitoes seem to be plentiful here and we have discovered that the tank of fresh water at present in use is full of mosquito larvæ.

1906

Light breezes from all quarters of the compass and fine weather throughout the day.

February 10: All hands ashore collecting. Beck returned late in the afternoon, having found a live tortoise, the first that had been taken on Chatham in many years. Nelson went out in the skiff to take some soundings and found that there is only six or seven feet of water at low tide where the chart shows 15 feet. Williams went ashore to do some night collecting, and, as the tide was going out, the skiff was left high and dry, so he could not get it off alone. He built a fire to summon help and King and I went in and helped launch the skiff. Light showers during the morning, clearing up somewhat in the afternoon. The *Josephine Cobos* left for Wreck Bay at 4:00 P. M. Mosquitoes are thick and troublesome, both on board and on shore.

February 11: Late breakfast, today being Sunday. Put out the kedge this morning and hove the schooner a little further into the cove, as she was touching bottom at low water. Later on, we put out the kedge again and hauled her further in, as she touched on the reef forming the outside of the cove. Beck and Gifford ashore taking photographs. Fine, clear weather and plenty of mosquitoes still with us.

February 12: All hands ashore collecting. Nelson put out the kedge astern to hold the schooner in position, as she was touching bottom at low tide. This morning Beck and I started inland on a tortoise hunt with all the water we could carry and three days' provisions, King helping us in part way and then returning to the schooner. We traveled through rough country much overgrown with cacti and thorn bushes. It started raining early in the afternoon and we both got thoroughly soaked. Towards nightfall we began to think of a camping place for the night, and, as we walked through the brush, came upon a fairly good sized tree protruding from a hole in the ground. Getting onto the top branches and climbing down, we found ourselves in an immense cave. As it was just about getting dusk, we gathered some firewood and built a fire to cook supper and to dry our clothes. The cave proved really to be a huge lava tunnel, and, getting well in from the mouth where the ground was perfectly dry, we lay down and

1906

went to sleep, waiting for the morning to explore our camping place.

February 13: Most of the party ashore collecting. Nelson remained on board to paint the counter at low water. Beck and I awoke early in the morning and, after a breakfast of hardtack and coffee, started in to explore the cave or tunnel we were so lucky to find. It proved to be some 50 or 60 yards long and in it the skeletons of 17 tortoises were found. They had no doubt fallen down the mouth of the tunnel and starved to death many years ago. We took two of the best preserved shells and all the best preserved skulls and bones, packing them in moss for transportation back to the schooner. Leaving our gear and specimens in camp, we started off to look for some living tortoises, but after traveling all day through the heavy undergrowth returned to camp without having seen a sign of a living tortoise. We cooked supper and turned in after a hard day's work. Weather cloudy throughout the day, but fortunately for us it did not rain.

February 14: Nelson busy cleaning and painting the schooner's waterline. The schooner was aground at low water and her stern lifted about a foot. Beck and I turned out early in the morning and, after a breakfast of coffee, hardtack and beans, started back for the coast, each carrying a tortoise skeleton. Our provisions being exhausted and our water supply being low, relieved us of much weight and traveling was fairly easy. Reaching the landing place at 5:00 P. M., we found that Nelson had shifted the schooner's berth into deeper water and held her in place with the kedge. Weather somewhat unsettled with some passing showers and rain squalls.

February 15: All hands up at 6:30 to get the schooner under way. We hoisted all boats and hove short, but, the wind being very light and unsteady, we were not able to break out the anchor till 7:30, when we got a light wind from the eastward. The schooner touched bottom passing out of the cove, but no damage was done. The wind freshened during the afternoon and we tacked ship twice as it hauled around. At 6:00 P. M. Finger Point bore by compass S., distant five miles. During the night the wind hauled SE. but was not

1906

steady. At midnight Finger Point bore S. by W., distant seven miles.

February 16: Opened with clear weather and unsteady winds from the southeast. We worked up to the north end of Chatham during the day and at 6:00 P. M. were close inshore to the westward of Terrapin Roads. At midnight the north end of the island bore by compass S.S.E., distant six miles.

February 17: Opened with very light winds from the E.S.E. and a strong current was sweeping down towards Finger Point again. At noon we were uncomfortably near to Kicker Rock and came very near being swept against it by the strong current. However, fortune favored us, and, as we passed very close to it, the wind freshened and we tacked off shore. At 4:00 P. M. we passed Finger Point again and made short tacks close inshore. At midnight Finger Point bore by compass SW. by S. $\frac{1}{2}$ S., distant five miles. Fine weather during the day.

February 18: Opened with clear weather and light variable winds. This morning, making short tacks, we worked the schooner close inshore and at noon we were within one mile of North Cape. However, owing to the strong current against us, we could make but little progress and at midnight Finger Point bore S SW. by compass, distant about 20 miles.

February 19: Opened with fine weather and light southeasterly winds. Took advantage of the fine weather to oil down the jib-boom, also the fore, main and staysail booms. Tacked ship at 5:30 P. M., Mount Pitt bearing by compass SW. $\frac{1}{2}$ W., distant about 25 miles. Fine, clear evening and we have an excellent view of the Southern Cross to the south-eastward.

February 20: Opened with light southeasterly winds and fine weather. At 5:30 A. M. tacked ship, and again at 11:00 A. M., when Mount Pitt bore by compass S. by E., distant eight miles. At 1:00 P. M. shaped course for Wreck Bay, as we found it impossible to round the east point of the island. The wind died down at 8:00 o'clock and we had only small puffs during the night. At midnight Kicker Rock bore NE. by N., distant $4\frac{1}{2}$ miles.

1906

February 21: Very light unsteady winds and calms up to 4:00 A. M. Towards daybreak the wind steadied down to the southeast and we made up to Wreck Bay, letting go anchor at 6:15 in five fathoms of water. After breakfast, a shore party landed, King and I staying on board to skin a couple of tortoises. Hunter went up to the hacienda after mail and found that a revolution had taken place in Ecuador since our last visit to Chatham and that a new Governor had arrived. Fine weather and quite warm today.

February 22: Shore party landed and went up to the hacienda. A negro, who acted as our interpreter when occasion offered, guided us south of the plantation to a small lake, out of which flowed a stream in the direction of Freshwater Bay. We found the country similar to that around the main peak, great open grass lands. In this type of country there seemed to be a scarcity of bird life and no reptiles at all. Some sailors from the trading schooner *Manuel J. Cobos* came aboard this afternoon and brought us some bananas. The talk of the village is the revolution in Ecuador. Fine weather during the day with southeast winds during the morning, shifting to the westward in the afternoon.

February 23: All hands ashore collecting. Gifford and I went up to the hacienda and purchased some Guayaquil chocolate at the store. The natives brought us down several bunches of bananas, for which we gave them some hardtack in return. Today the thermometer went to about 80°, the highest we have seen it since arriving in the Galapagos. Williams ashore this evening collecting with a light and securing many excellent specimens of moths. Fine weather with southeast winds during the morning, changing to northwest in the afternoon.

February 24: All hands up for early breakfast. Beck went ashore to settle accounts with the plantation manager and Williams to get food for some caterpillars he is raising. Everybody was back on board at 8:00 A. M. and we hove short. Just as we were about to break out the anchor, the Governor, who came to say good-bye, and a boatload of sailors from the trading schooner came alongside with a load of bananas. When Beck asked them if they wanted some whiskey there

1906

was a loud and immediate response of "Si si señor!!" Our stock of whiskey in the medicine chest being somewhat depleted, Ochsner and I arose to the occasion, and, hurrying down below, got some clean alcohol out of a barrel, diluting it to about 75 per cent. A hurried trip to the galley was then made, and some juice bailed out of a dish of stewed prunes gave our home brew the desired coloring. After shaking well, we poured the concoction into a whiskey bottle. In less time than it takes to tell it, we had a drink that seemed to hit just the right spot, as the sailors drank it down in great gulps. The Governor made some queer facial contortions and seemed to think all was not well, as he declined a second drink, a thing never heard of in these latitudes. However, he was too polite to say anything and thanked us profusely. Bidding our guests good-bye, we got under way, and, clearing the entrance to Wreck Bay, shaped our course for Charles Island. Weather fine during the day with light southeast winds. At midnight Enderby Island bore by compass SE. $\frac{1}{2}$ E., distant two miles.

February 25: Opened with light unsteady winds. Shaped course around Onslow Island and at 2:00 A. M. let go anchor in Comorant Bay in $5\frac{1}{2}$ fathoms of water. Strong current setting to the S. SE. After breakfast, Beck and Gifford went ashore to take photographs. There is a fine lagoon opposite our anchorage with great flocks of ducks and flamingos on it. Today being Sunday, we had late dinner and kept the rest of the day a holiday.

February 26: All hands up for early breakfast. Nelson and Gifford took the small skiff and pulled over to Champion Island, the rest of the shore party landing at the lagoon. Beck, Hunter and Ochsner got about 24 flamingos and some ducks between them. All hands were back on board at 2:15 and we set sail for Black Beach Roads. The wind failed us shortly after we got under way and at 8:00 P. M. we were a mile or so off Black Beach. At 10:00 P. M. we let go anchor about half a mile to the southwestward of the anchorage in ten fathoms of water.

February 27: Weighed anchor at 7:00 A. M., shaping course for the Black Beach anchorage. We made the anchorage at 7:45 and let go anchor in seven fathoms of water. Had

1906

flamingo for breakfast this morning. It tastes much like duck, but is a little more dry and has somewhat of an oily taste. Nelson and Ochsner went up to the spring to camp over night and get some fresh beef. Rainy weather all morning, clearing up about noon. The island is fine and green at the present time and showers are frequent.

February 28: All hands ashore collecting. Williams and I started up to the spring and, on the way, met Nelson and Ochsner coming down the trail loaded with beef and pork, as they had also killed a pig. They returned during the afternoon and we all spent the night in some caves near the spring. No doubt one of these was the cave inhabited by Patrick Watkins, the Irishman who lived on Charles in 1809. We found sheves and a fireplace cut out of the solid lava. Flies and fleas made things interesting for us in our new-found home. Nelson acted as camp cook and we had beef, flapjacks and coffee for supper. We heard many wild dogs and donkeys during the night, most of which was spent keeping the fleas on the move.

March 1: All hands up at daybreak. Hunter went after more beef, while I returned to the schooner to skin out a tortoise which had died yesterday. Williams and King brought a load of lemons and oranges down to the schooner. An immense lemon thicket covering the plateau on top of the island and the orange trees growing about the spring furnish us with a plentiful supply of fruit. Nelson and Ochsner stayed in camp for the night. Fine, warm weather with light variable winds.

March 2: All hands ashore collecting and gathering oranges and lemons for the mess. At 5:30 P. M. we weighed anchor and set sail for south Albemarle. Steered NW. up to midnight, when Brattle Island bore by compass N.NE., distant three miles. Fine weather during the day.

March 3: Opened with fine weather and light northeast winds, freshening towards afternoon. Schooner drifting to the westward on account of the strong current. We tried to beat up close inshore, but, the wind failing us at 7:30 P. M., we let go anchor off the Albemarle coast in eight fathoms of water. Brattle Island bore by compass E. by N. $\frac{3}{4}$ N.

1906

March 4 Opened with moderate easterly winds and fine, clear weather. After breakfast, Beck and Nelson went ashore opposite our anchorage to see if the country was worth while investigating, but found nothing that would warrant our stopping. At 10:00 A. M. got under way and beat up the coast against a light breeze. We arrived outside Turtle Cove at 6:00 P. M. and let go anchor in five fathoms, as the captain of the brigantine *Nellie*, which we found at anchor, told us that the bottom of the cove had changed owing to a recent earthquake.

March 5 Landing party ashore after breakfast. The brigantine *Nellie* started loading cattle for Guayaquil this morning. The captain expects to take about 60 head and get them over alive. The *Nellie* has an auxiliary wood-burning engine and makes about five knots an hour in calm weather. Nelson brought some ship's stores ashore this morning to trade for tortoises. Flour is very much in demand and most welcome. All hands aboard for supper. Weather fine and clear with light easterly winds.

March 6 Landing party ashore after breakfast. One of the natives guided Ochsner to a bed of fossils some distance inland. Williams and I went up the trail leading to Santo Tomas, the settlement part way up the mountain, and returned to the beach early in the afternoon. The crew of the *Nellie* is busy loading supplies and fodder for the cattle. This evening we sent some letters over to the captain, as he expects to get off in the morning. Several of us sleeping on deck now, as it is quite warm below in the cabin. Fine weather during the day with light southerly winds.

March 7 The brigantine sailed at 8:00 o'clock this morning for Guayaquil. Hunter and Gifford left for Santo Tomas. Don Antonio Gil, the owner of the settlement, having furnished them with a couple of mules. Rest of the party collecting about the vicinity of Vilamil. Nelson busy watering ship. The water here is salty and tastes strong of sulphur. The best you can say for it is that you can drink it without getting sick. Herr Brugermann, the German book-keeper for Don Antonio, came aboard this evening for supper. Fine weather with fresh southerly winds during the day.

1906

March 8: Beck left at noon to go up to Santo Tomas and stay over Saturday. Hunter and Gifford returned this afternoon, reporting that they had seen hundreds of tortoise skeletons scattered along the trail and about the waterholes. No living tortoises were seen below the settlement and the natives report them as having been killed off in that vicinity. However, they report them common about the top of the mountain. I stayed on board today and made some fresh pickle for soaking the tortoises. King helping Nelson water the schooner. Don Antonio Gil came aboard and had supper with us this evening. Fine weather with light southerly winds.

March 9: King and Nelson working all day watering ship. Williams and I worked along the beach to the westward of the settlement and came back early in the afternoon to help with the water breakers. Ochsner and Beck still up at Santo Tomas. Rest of party working about the settlement. Fine weather with strong easterly winds.

March 10: This morning we finished watering ship, having taken on board 1,050 gallons. Beck and Ochsner returned from Santo Tomas early this afternoon and all hands were on board by 3:00 P. M., when we weighed anchor and proceeded down the coast to the westward of Vilamil, anchoring off a long sand beach at 7:45 P. M. in seven fathoms of water. Light southerly winds during the day, falling calm about 5:00 o'clock, when we drifted with the current. A long rolling swell makes the anchorage rather uncomfortable as the schooner lies broadside to. Had a light shower of rain during the night.

March 11: Went ashore with Beck and located two tortoises, returning to the schooner at noon. Rest of party keeping the Sabbath. Not much work done today, as it is the first Sunday we have taken off for some time. Weather fine and warm. Calm during the morning with fresh southeast wind during the afternoon.

March 12: All hands, with the exception of Parker and White, who were left in charge of the schooner, took both skiffs and, pulling down the coast about two miles, landed at low tide on a fine sandy beach, back of which we found the wreck of an old grass house, probably the last remains of

1906

what is known as the Old Cobos Settlement. A large lagoon was found just back of the beach, surrounded by a growth of mangroves and big trees. Tracks of wild cattle were all about the edges and two tortoises were found half buried in the mud close to the bank. Hunter, Nelson and Ochsner went hunting cattle and shot a large, red and white bull. We had some of the meat for supper and wouldn't blame anyone for being a vegetarian if they had no other meat than Albemarle bull. Beck, King and myself went after tortoises and found several. They are not rare in this particular locality. We skinned out one large male and packed it down to the beach, so we could pick it up with the skiff as we pulled back to the schooner. Making our way back to the landing, we got lost in the mangrove swamp, and, as the tide was coming in, we had to make our way through the tops of the trees. Finally arriving at the skiff, we found it floundering about in the mangroves and half full of water. Nelson, Hunter, Ochsner and Gifford had already left for the schooner. With the assistance of Williams, we beached the skiff and dumped the water out. Making a good getaway through the breakers, we reached the schooner shortly after six o'clock, having left ashore the tortoise we had skinned in hopes that we can pick it up in the morning. King is a little under the weather this evening, having drunk too much water out of a mudhole near the lagoon. We heard several wild dogs barking while we were ashore, but none came near enough for us to see them. Quite warm now and nearly everybody is sleeping on deck tonight.

March 13: Had heavy showers this morning with the wind blowing off the land. Went ashore with Beck, Nelson and Gifford. Beck and I, taking advantage of the low tide, packed the tortoise we skinned yesterday around by the beach to the landing place. We then went inland after more tortoises, while Nelson went after fresh meat for the mess. We found one tortoise, and, roughly skinning it out, made full speed for the coast, reaching the skiff just before dark. Nelson and Gifford were awaiting us, the former having shot a fine young calf. Launching our boat, we pulled back to the schooner, arriving at 7:30.

1906

March 14: All hands up for early breakfast. At 7:00 A. M. weighed anchor and set course for Cape Rose, a few miles to the westward of our present position. At 9:00 A. M. we got a very light breeze from the southwest, which held on during the day and fell to calm late in the afternoon. We had the big skiff out to try and pull the schooner's head around, but could make no headway and at 6:00 P. M. let go anchor in 13 fathoms of water $\frac{1}{4}$ of a mile to the eastward of Cape Rose. King and I finished skinning the tortoise taken yesterday. Hunter busy mending shoes for the party, he being the official shoemaker. Early in the evening some rain squalls passed over us and the top of Iguana Cove Mountain was buried in clouds. Considerable swell running and it makes the anchorage somewhat uncomfortable. A great many sea turtles about this part of the coast, more than we have seen any place so far.

March 15: A landing party, consisting of Nelson, Hunter, Williams and Stewart, pulled down the coast, passing the westerly point of Cape Rose, but could find no sand beach or place to land, as the surf was too high on the rough boulder-strewn shoreline. Returning to a point nearer our anchorage, they made a landing in the shelter of a small rocky point. Beck, King, Ochsner and myself, in another boat, kept on down the coast past Cape Rose and found a small cove and sand beach which afforded excellent landing. We found a small rough lava plateau well cut up with cattle trails and with a heavy growth of cactus. It proved to be excellent tortoise country, as we found six during the day. We returned to the schooner at 7:00 P. M. with six tortoises and four men in a 14-foot skiff, rather a heavy load, as it left us with about an inch freeboard. Weather partly cloudy with a few light showers. Light southwest winds in the afternoon, with the morning calm.

March 16: All hands up for early breakfast. At 7:00 A. M. weighed anchor and set sail for Iguana Cove. Very light winds and calms. At 8:30 we had to let go the kedge to prevent drifting ashore. At 9:30, a light westerly breeze sprang up and we hove up the kedge and stood off shore. By 6:00 P. M. we had made three miles to the westward. King

1906

and I skinned tortoises all day. Wind freshened during the evening and hauled towards the north. Several small rain squalls passed over us.

March 17: Opened with calms and light airs, the breeze freshening later in the morning. At 10:00 A. M. we made up to Iguana Cove and sent a boat in to sound for an anchorage. Nine and a half fathoms with rocky bottom was found about 150 yards off shore and the spot was buoyed. At noon we brought the schooner up to the buoy and let go anchor. There is a very heavy surf breaking over the point and the schooner rolls considerably. Iguana Cove Mountain towers above us and is so green and densely covered with trees that it somewhat resembles the tropical jungle of Cocos Island. Many steep rocky cliffs, bare of any vegetation, can be seen on the mountain side. The shoreline here is most forbidding and ends in abrupt cliffs with heavy rollers breaking against them. Beck, William, King and myself took the small skiff and pulled about two miles down the coast, the remainder of the shore party landing at the cove. We located a small boulder beach, on which we landed with no great difficulty, and proceeded inland after tortoises. Back of the beach we found a small flat covered with a dense growth of brush and cactus, which made it necessary in places to follow the tortoise trails on hands and knees. We had been hunting only a short time when we found three large males. The three of them were only a very short distance from the beach, so we drove them down to the landing place by prodding them with sticks. As it was getting late in the afternoon, Beck decided to load all three tortoises into the skiff and pull back to the schooner. As the tortoises were quite large and heavy, we could not launch the skiff with all three in it, so Beck thought we might be able to parbuckle two of them in. We put the first one in and launched the skiff, then started to parbuckle tortoise number two into it. However, this was not so easily done. We listed over the skiff and got the tortoise part way in when its front leg got foul of a thwart and we could neither get it in nor out. During this procedure our skiff turned broadside on to the swell and, an extra heavy roller coming in, the skiff capsized, throwing both tortoises, the oars.

1906

and the remaining contents of the skiff overboard. Fortunately, King, who could not swim, was left on the beach and saw the tortoises and some of the oars go floating out to sea. Beck could not swim either, but hung on to the stern of the skiff. Both Williams and myself felt perfectly at home in the water and finally got the skiff righted. Beck crawled in over the stern and, finding one oar which had caught in a thwart as the skiff went over, got it into action and sculled for the shore. We all landed on a rough ledge of boulders, getting somewhat cut up on the sharp edges of the lava, but otherwise none the worse for wear. Beck took the painter and started hauling the skiff along the edge of the rocks, when an extra heavy swell coming in crashed it down on a sharp point of rock, smashing it to pieces. All that was left on the painter was the ringbolt. As it would soon be dark, we decided to make down the coast for the schooner. Beck had lost his shoes and had to go in stocking feet. Fortunately I had left my pants, shoes and hat on the beach, and was a lot better off, having lost only a shirt. As we walked through the brush in the dark, I felt as if there was not a cactus or thorn bush on all Albemarle Island that I missed running into. However, I wouldn't have traded places with Beck for anything. When it got to be 7:00 o'clock and the boys on the schooner saw no signs of the skiff returning, a searching party was organized and Nelson, Ochsner and Hunter put off in the other skiff to hunt for us. As we were making our way slowly along the coast, we heard a whistle and, looking out on the water, saw a light. We then hailed the boat and told them to keep away from the shore, that we had lost our boat and that nobody was hurt. Nelson answered back and told us he would pick us up at the cove. After what seemed a journey that would never end, we reached the cove at 9:15, tired out and very hungry. The skiff picked us up and brought us on board for a much-belated supper. Thus ended the 263rd and about the most exciting day of the voyage. Fresh S.E. winds make us practically anchored on a lee shore and the navigator is quite ill at ease.

March 18: Sunday morning and late breakfast. Williams, happening to go on deck, sighted one of the tortoises we lost

1906

yesterday drifting down past the anchorage. It was bobbing about like a cork, its long neck protruding far out of the water and giving it a very grotesque appearance. We put out a boat to the rescue, and, making a line fast around one of its legs, towed it to the schooner. Several pieces of our skiff came floating by as we proceeded with our tow, but we sighted nothing worth picking up. Later on another tortoise was sighted and we put out in the skiff to rescue it. This one had evidently had a rough passage, as its shell was broken and punctured by being battered against the rocks. A great number of pelicans, sharks and penguins about the schooner today. We had two good showers of rain during the day and the weather is quite sultry. Showers continued during the night, making us sleep below.

March 19: Beck and I went down the coast to where we lost the skiff and picked up some wreckage. We also got the tortoise left behind on Saturday. We found two more, which we tied up till we can come back for them tomorrow. Rest of the party landed at Iguana Cove. Rainy weather with light variable winds.

March 20: With Beck, Ochsner and Nelson, went down to where we tied up the tortoises yesterday. The coast is bold and rocky where the tortoises were found, and, as they were too big and heavy to pack out alive, we lowered them over the cliffs with ropes and let them drift out to sea, where we picked them up with the skiff and towed them back to the schooner. We got three tortoises off and got back to the vessel at 5:30 P. M. King stayed on board and skinned out one of the tortoises we picked up yesterday, it having died of its injuries. Weather calm and sultry with cloudy sky. One shower passed over us this afternoon.

March 21: Landing party ashore collecting about the cove. Beck and Ochsner brought back some large sea iguanas and Hunter several penguins. King and I stayed on board and skinned out two tortoises which died of injuries received while being lowered over the cliffs into the water. At 10:00 A. M. all hands returned on board and we weighed anchor, shaping our course for Narborough Island. Had a fair breeze and at times the schooner logged seven knots. At sundown

1906

we hove the schooner on the wind off the east end of Narborough. Weather clear and warm with southerly winds, becoming almost calm towards midnight.

March 22: Opened with calms and light airs, the wind freshening towards noon. At daybreak we were not far from last night's position. At 8:00 A. M. we made up to the east point of the island and sent a party ashore, the schooner standing off to windward of the landing place. The island appears as one large cone of black lava with a few patches of green on the sides. The top is often above the clouds. Landing party returned at noon, having found a colony of flightless cormorants and a herd of sea-lions. They report the country most desolate, the worst we have seen so far. Our course was now shaped for Tagus Cove, north Albemarle, which was reached at 3:30 P. M., and we let go anchor in 14 fathoms of water with fine sandy bottom. Tagus Cove, named after H. M. S. *Tagus*, is by far the the best anchorage in the islands. Beck, Ochsner and Williams pulled over to the waterhole, which is just outside the cove, and about a mile below the entrance. They returned at 5:00 P. M., having found the main waterhole was full. We get about a barrel of water a day out of it and find it of much better quality than that taken aboard at Vilamil or Academy Bay. King and I stayed on board all day skinning tortoises. Weather warm today with fresh northerly winds at nightfall.

March 23: Opened with strong gusts of wind blowing from between the hills about the cove and causing the schooner to swing to her moorings in all directions. Nelson and I stayed on board and overhauled the fore hold, restowing some of the provisions to make room for tortoises. Beck and King went inland and found two tortoises, one of which they skinned and packed out. Rest of party working at various jobs on board the vessel. The wind went down towards evening and the cove became as calm as a millpond.

March 24: Went inland with Beck and King to skin and pack out one of the tortoises found yesterday. Rest of party ashore doing general collecting. Nelson took aboard 50 gallons of water from the waterhole. Unsettled fresh winds inside the cove. Outside, it is steady from the S.S.W. Some of

1906

us went swimming over the side, but did not stay in long on account of the sharks, which appear to be numerous about here, several having been sighted today.

March 25: Late breakfast, today being Sunday. Helped Nelson water the schooner. Took 50 gallons aboard. Williams put a line over the side and caught several fine fish, which we had for supper. Light variable winds during the day and calm weather in the evening.

March 26: Beck, Ochsner, Stewart, Gifford and Williams, carrying all the provisions and water possible, started inland to climb Tagus Cove Mountain, King and I going part way in with them and then leaving to skin and pack out a tortoise we had tied up. The mountain climbers followed up the lava flows, in order to avoid the heavy brush, and reached the summit at 5:00 P. M. after a rough trip. Part way up the mountain, Beck and Williams, having found a large, green tree with plenty of soil around the base and leaves to shelter them from the sun, made camp. While Williams collected about their camp, Beck went out hunting for tortoises, finding three fair sized ones close at hand. Nelson fumigated the schooner today, as the bedbugs, dermestes, flies and cockroaches were getting too thick for comfort. He also took advantage of the smooth water in the cove to clean off the waterline. Weather fine and clear with light unsteady winds.

March 27: Nelson opened up the cabin and hatches this morning and found plenty of cockroaches still alive, the dose of sulphur not having been strong enough. However, we got rid of some, as well as a quantity of flies. Shore party still camped up the mountain. Williams left camp this morning and made the summit, reaching it shortly after 10:00 o'clock. No real green zone was found, but maidenhair ferns and moss grew in cracks and crevasses in the lava. The summit of the mountain is comparatively flat, with a fine crater about two and one-half miles in diameter, some hundreds of feet deep, and abruptly sunken in the middle. Williams returned to camp at noon and helped Beck carry a tortoise down the lava flow, where King and I met them with a supply of water, and packed the tortoise out to the coast. Beck and Williams re-

1906

turned to camp for the night. Fine weather throughout the day with light, unsteady winds and calms.

March 28: King, Hunter, Ochsner and myself went up the mountain to pack out two tortoises. Beck and Williams had one skinned out when we arrived at their camp. Skinning out the other, we packed them both down to the coast. Beck and Williams broke camp and returned to the schooner, all hands reaching the landing place at 6:00 o'clock. Nelson let out the port anchor and chain to lighten the bow so the water line about the cutwater could be painted. All hands aboard for supper, the first time in some days. Fine, clear weather with light unsteady winds.

March 29: Beck, King and myself went up the mountain to re-establish camp and hunt for tortoises. Beck found two small tortoises while en route to the foot of the mountain and carried them back to the landing place, returning to the foot of the lava flow, which we used for a trail up the mountain and camped there over night. Williams and I went along up to the tree where the original camp was made and had to go with a cold supper and no fire at night, as Beck had the entire supply of matches with him. Nelson busy on board the schooner, painted the waterline on the port side and greased down the foremast. Fine, clear weather with light westerly winds.

March 30: Beck, King and myself in camp skinning tortoises. Four of the party came inland and packed out two tortoises we had skinned for them on arrival at camp. We have two more tied up ready to skin and pack out tomorrow. The tortoise packers reached the landing at 5:30. The tortoises here are not thick-shelled and heavy and the country is fairly open, so packing is not as hard a job as in some places. However, the distance they have to be packed makes up for this to some extent. Today Nelson gave the waterline another coat of paint and greased the mainmast. Took 50 gallons of water on board today. Fine, clear weather with light airs and calms.

March 31: Two of the party came in to help out with one of the tortoises. We had two skinned out by noon and broke camp. King and I on one tortoise and Hunter and Ochsner on the other, started for the coast, arriving at the landing at

1906

6:00 o'clock. Nelson painted the waterline on the starboard and took on board 50 gallons of water. Fine, clear weather with light variable winds and calms.

April 1: Nelson gave the starboard side a second coat of paint and took on 50 gallons of water. Williams put over the fish line and caught several nice fish, some of which we had for supper. All hands resting during the afternoon, it being Sunday. I mended some clothes and shoes today after a week of tortoise packing. Fine, clear weather with light variable winds.

April 2: Went up the mountain with King to pack out another tortoise we tied up Saturday. Beck, Hunter and Nelson left in the sailboat for Narborough Island with provisions and water to last about four days. They landed at Mangrove Point late in the afternoon, Beck and Hunter starting up the mountain, leaving Nelson in charge of the boat. King and I reached the tortoise we had tied up late in the afternoon and made camp for the night. Fine weather with light variable winds.

April 3: Party still collecting on Narborough. Hunter returned to the coast at 3:00 o'clock this afternoon and found Nelson collecting some flightless cormorants and lizards. Beck kept on towards the top of the mountain and found a tortoise in an isolated patch of green brush. He skinned this tortoise out and packed it down to the coast on the return trip. Reaching the top of the crater, he found the rim covered with high grass and ferns. On the floor of the crater two small lakes were visible. Beck estimated the crater to be about 1,500 feet deep. King and I started skinning our tortoise out after breakfast, finishing the job about noon. We started down for the landing place shortly after lunch, reaching it about 5:00 o'clock. Williams attended to watering the schooner in Nelson's absence and took aboard 50 gallons. Fine, clear weather with calms and light airs.

April 4: Boat party to Narborough still working that island, Hunter and Nelson about the beach and Beck up the mountain. King and I went around the north side of Tagus Cove Mountain to try and locate a tortoise Beck had tied up,

1906

but could not find it. We had a fine view of Cape Berkeley, a high, steep promontory to the northward. The entire north slope of Tagus Cove Mountain appeared to be fresh lava. We had to give up our search for the tortoise about the middle of the afternoon, so as to reach the coast before dark. Fine breeze from the northeast this afternoon, followed by calms towards evening.

April 5: King and I went to the base of the mountain hunting for land iguanas and found two. They are very scarce on Albemarle, having been killed off by the wild dogs. Williams and Stewart went inland prepared to camp over night. They made camp at our regular camp tree and were so bothered by mosquitoes they were unable to sleep. Williams spent the night collecting about the camp fire. Beck returned to the landing place on Narborough at 5:00 P. M. and found Hunter and Nelson awaiting him. After supper, the boat was loaded and at 7:00 P. M. the return journey to the vessel was begun. Light winds and calms made progress slow and they did not reach the vessel till the following afternoon.

April 6: Stayed on board all day and worked on tortoises and iguanas. Williams and Stewart arrived on board early this afternoon, having been up most of the night collecting. At 5:00 o'clock this afternoon the party from Narborough returned, having taken nearly 24 hours to make the journey across the channel. Beck reported land iguanas to be quite common and found them clear up on top of the mountain. The tortoise was the only one seen by any of the party. Light breezes and calms throughout the day.

April 7: Went inland with Beck and King to get the tortoise we were hunting for the other day. We found it a long way from the place where we were looking, according to the directions given by Beck. Skinning out this tortoise, we packed it back to the landing place. This makes the fourteenth tortoise from Tagus Cove. Some of the party mending shoes and making preparations for a trip to Banks Bay, north Albemarle. Light, unsteady winds during the day, falling calm towards sundown.

April 8: All hands keeping the Sabbath after a week of tortoise packing. Fishing and mending clothes and shoes

1906

indulged in. Light, unsteady winds and calms during the day.

April 9: All hands up for early breakfast in order to prepare for the trip to Banks Bay. Nelson and I broke out provisions from the hold and loaded the sailboat, stowing two water breakers and provisions for a week in her. We covered the cargo with a tarpaulin, just leaving room for the two of us in the cockpit. We shoved off from the schooner at 2:00 P. M. under a light head wind and beat up the coast towards Banks Bay. At 10:00 P. M. it was dead calm and a heavy fog closed in on us. We were too heavily loaded to make good use of the oars, so we both kept a sharp lookout during the night in order not to be carried ashore by the current. The rest of the party, with the exception of Stewart and Parker, who were left aboard to look after the vessel, preparing to shove off in the skiff early in the morning.

April 10: All hands aboard the schooner up at 2:00 A. M. The boat party shoved off in the skiff with all the collecting gear and camp equipment. They pulled up the coast, taking turns at the steering oar, and passed through the fog bank that Nelson and I got caught in. Towards day-break, the fog lifting, we got a bearing of Banks Bay Mountain. At 9:00 o'clock we sighted the skiff coming up the coast. She soon overhauled us and took us in tow. At 10:00 o'clock we pulled into a quiet, shallow bight, and anchored the sailboat about a hundred yards off a beach of black sand on which were five small sea-turtles, many pelicans, boobies, sea iguanas, and a few flightless cormorants close to the landing place. We unloaded the sailboat and established camp on the beach back of the high tide line, putting up a tent for the bird skinners. At 12:30 the cook announced lunch was ready. After our breakfast of one hardtack and a drink of water, we needed no second invitation. On finishing a good, big meal, consisting of beans, hardtack and canned fruit, Nelson, Beck, King and myself started off for the mountain, loaded down with water and provisions. At 5:30 we pitched camp close by a small crater, from which a recent lava flow had come. While hunting around before dark, we found one tortoise close at hand and tied it up to a tree. Weather somewhat

1906

hazy during the day, with fog settling down on us towards evening.

April 11: Beck started out after breakfast to hunt for more tortoises, while I skinned the one found yesterday. Nelson and King returned to the beach after more water and provisions. They arrived back at camp towards evening, bringing Williams with them. Beck also returned towards evening, bringing in a small female tortoise. Weather fairly clear during the day with heavy fog settling down during the night.

April 12: Hunter, Ochsner and Gifford came in to our camp this morning to pack out the tortoise skinned yesterday. They also took the small female tortoise out alive. Beck, King, Nelson and I went out hunting for more. Two were found today, one of which we skinned and packed back to camp. We have tortoise liver every night and send some out to the boys on the beach every time a tortoise goes out. Fog still settles down on our camp early each evening, the days being quite pleasant.

April 13: Nelson, King and myself broke camp and packed two tortoises down to the beach, Beck going off in another direction to hunt for more. We met Williams on the way inland to help pack out some more. As there were no more found up to the time we left camp, he returned to the beach with us and prepared for a two-days' journey inland. Beck returned to the beach camp at 5:30 and reported having found two more tortoises, besides the one he brought in. Williams, Ochsner and Gifford went inland and camped at our regular camping place in order to get an early start in the morning. Weather still pleasant during the day, the fog settling down towards evening.

April 14: Beck, Nelson, King and myself started inland to skin out the remaining two tortoises and pack them out to the beach. The party camped inland, turned out early and started up the mountain, following an old lava flow in order to avoid the thick undergrowth. At 11:30, after reaching an altitude of 2,300 feet, a halt was made for lunch. Owing to lack of water, it was decided not to try another night out, so the party returned to the inland camp early in the afternoon.

1906

Here they found Hunter cooking supper. After a hearty camp meal, they set out for the beach, arriving there just before sundown. Our party, packing out the two tortoises, arrived just ahead of them. Weather continues as usual.

April 15: Today being Sunday, all hands took a rest and enjoyed a swim. This morning the sailboat broke away from its moorings and we had to launch the skiff and go to the rescue. We reached it just as it was about to hit on a reef and fortunately saved it from being damaged. Weather about as usual.

April 16: Beck and I started off towards a small hill, between the main mountain and Cape Berkeley, to look over the country for tortoises. After spending some time without finding signs of any, we headed back towards the main camp. During the forenoon, the rest of the party broke camp, loading supplies, camp gear, all the tortoises and three turtles in the sailboat. Nelson and White started off in it at 1:00 P. M., heading towards Tagus Cove, but made little progress on account of the light breeze. Beck and I reached camp early in the afternoon and got the remaining gear loaded into the skiff. We left the beach at 4:30 P. M. and started pulling down the coast towards Tagus Cove. We pulled one oar to a man, each taking a turn at the steering oar. Just about a mile below the cove we made our camp in, we picked up the sailboat and took it in tow. Taking half-hour turns at the oars, we reached the schooner at midnight, after a passage through a perfectly calm sea. We roused out Stewart and Parker, who prepared a midnight supper of stew, pie and cookies. All hands then turned in after a well-earned rest. Fine, calm weather with no fog this evening.

April 17: Turned out late this morning for 9:00 o'clock breakfast. All hands, with the exception of Hunter, White and Parker preparing for a trip to Narborough in the sailboat. Shoes had to be mended and provisions broke out for a two-days' trip. Leaving the schooner at 1:30 P. M., we made Mangrove Bay at 5:00 P. M. As we found no landing place to the northward, Beck decided to camp here for the night. We landed on a coarse sand beach in a well protected little cove and anchored our boat a few yards off, the last man

1906

swimming ashore. Williams and I found a turtle on the beach and killed it, cutting off some turtle steaks for supper. A light drizzle started after we landed and kept on well into the night. As Williams and I were asleep under a tarpaulin, a rat got underneath it and started to run over us. We both woke up to see what all the fuss was about and Williams caught the rat in his butterfly net, thus adding another specimen to the collection. When the rain ceased, we spent a more comfortable night.

April 18: All hands up for early breakfast. As there was no sailing breeze in evidence, we started to pull up towards the north end of the island. We made a landing on a rough, rocky coast, where the vegetation came down to the seashore, Nelson standing by with the boat while the landing party worked on shore. We have not seen such a desolate place since arriving in the Galapagos. Land iguanas seem to be plentiful and we collected about 20 specimens, besides a snake and some lizards. We left this spot about 3:00 o'clock and started to pull back towards our camp, stopping on the way at a low, rocky point, to get some flightless cormorants. We collected a number of these, putting them in sacks with holes cut in, so that they could stick their heads out. On arrival at camp at 5:00 o'clock, King and Williams killed another turtle, cutting off some steaks for supper. Building a fire on the beach, we turned in for the night. Quite foggy, but no rain. Beck intended leaving this afternoon for Tagus Cove, but the fog made this impracticable.

April 10: All hands turned out early. Beck and Gifford went after more cormorants, while the rest of us stowed all the gear and specimens in the sailboat preparatory to our trip across the channel to Tagus Cove. We got under way at 8:00 o'clock with a very light breeze and turned to on the oars in order to keep warm, as well as make a little headway. The fog was quite heavy and we steered by compass alone. Towards 10:00 o'clock the fog lifted and we got a bearing of Tagus Cove Mountain, finding we were on the right course. Later in the morning, a little breeze springing up, we made some headway and reached the schooner at 11:15, finding all

1906

well on board. At 1:45 P. M. we weighed anchor and set sail for Vilamil, south Albemarle, with a fine breeze from the north, which soon shifted ahead and died down towards sunset, when it turned calm. At midnight the mountain peak of Narborough bore W. by N. $\frac{1}{2}$ N.

April 20: Opened with light unsteady winds and heavy fog, which cleared about 9:00 A. M. Wind freshened from the SW. later on in the morning, and at 6:00 P. M. Point Christopher bore by compass SE., distant two miles. The fog shut down on us again towards evening and, with a good sailing breeze, we stood off the land on the port tack.

April 21: Fog cleared off early and we got a bearing of Essex Point bearing by compass N.NE., distant about 22 miles. The schooner was put on the starboard tack and at 6:00 P. M. the point bore N., distant about 15 miles. Weather cloudy and threatening, but no rain.

April 22: Opened with light variable winds and fog. It fell calm during the afternoon and we made but little headway, the current setting us back towards evening. Many shearwaters circling about the schooner most of the day. At nightfall we were in a dead calm. King and I keep busy all day skinning tortoises, when not standing our watch at the wheel.

April 23: Opened with calm and clear weather. This morning the skiff was put out and Beck went shooting birds. A light breeze sprang up about 11:00 o'clock, but it soon fell calm again. Great numbers of shearwaters circling about the schooner most of the day and an immense school of tuna and a smaller one of porpoises crossed our bow as we lay becalmed. At midnight we were about eight miles S. of Essex Point.

April 24: Dead calm up till 7:00 A. M., when a light breeze set in from the westward and continued throughout the day. Beck went out in the skiff this morning and shot a number of birds. Towards evening, we made up to the Albemarle coast and at 6:15 let go anchor in seven fathoms of water about nine miles to the westward of Vilamil, the wind having died out. Cape Rose bore by compass SW. by W.

1906

½ W. and an unchartered rock some miles off shore E.S.E. Heavy swells make the anchorage somewhat uncomfortable.

April 25: All hands, except Parker and White, ashore to collect and get some fresh beef. Beck, King and myself went hunting for tortoises and Nelson and Hunter went after beef. They saw several cattle they could not get a shot at, but managed to bring down a young bull close to the landing place. They carried several loads of meat down to the skiff and we brought it on board to see what could be done in the way of salting it. Some distance inland Beck ran across a tortoise, which King and I skinned and packed out. We saw several dogs, which were not particularly wild and which we could easily have killed had we the rifle with us. We left the landing at 6:15 P. M., encountering heavy swells well off the beach. The skiff had a narrow escape, just getting over the crest of one as it broke. We got back to the schooner at 7:05 with one tortoise and a load of meat. Full of mosquitoes on shore about the ruins of the Old Cobos Settlement. We found the wreck of an old stone tortoise pen and several thatched houses just back of the beach. Partly cloudy with light southerly breezes, followed by calm towards evening.

April 26: All hands ashore again at 7:00 o'clock. We landed at the same place as yesterday, Nelson and Hunter going after beef. King and I skinned and packed out another tortoise. We returned to the schooner at 6:00 P. M. with the tortoise and a load of cow meat for salting down. Fine day with light southerly winds.

April 27: Opened with dead calm. At 10:00 A. M. we hove short and hoisted the fore and main sails to await a breeze. At 1:00 P. M. we got under way with a very light breeze and shaped our course for Vilamil. After making about four miles to the eastward, the breeze died down and, at 5:00 P. M., we let go anchor in seven fathoms of water about three-quarters of a mile off shore.

April 28: Opened calm with cloudy sky. Beck and Gifford went out in the skiff shooting birds. About noon a very light southerly breeze sprang up and we hoisted anchor, again shaping our course for Vilamil. We could make no headway,

1906

so at 1:00 o'clock we let go the anchor again so as not to get too close inshore. At 3:00 P. M. we weighed anchor again for another try, but in ten minutes let it go again, not being able to make any headway. At 6:00 P. M. we lowered the sails and secured the vessel for the night.

April 29: Opened with dead calm. A very light breeze which came up towards noon died down shortly afterwards and the schooner lay with the chain up and down. Along the stretch of fine sand beach we were anchored opposite, we saw several cows with calves following them along, but the surf was too high to attempt a landing, so we lost a good chance to get some beef.

April 30: Opened with cloudy sky and light southeast wind. At 7:30 A. M. we weighed anchor and again set course for Vilamil. Weather cleared and wind freshened towards noon. We made the anchorage at Vilamil at 2:30 P. M., letting go anchor in four fathoms of water. When the schooner swung to her moorings she was too close to the reef, so we got out the kedge and hauled her off a little. The Ecuadorian gunboat *Cotapari* was at anchor, and from her we got a Guayaquil paper announcing the fact that there had been a terrific earthquake in San Francisco and that the soldiers had been ordered out on the streets. This was the first and all the news of the great disaster that we had for some time. The *Cotapari* sailed at 3:30 P. M. for Guayaquil via Chatham Island. One of her crew died of yellow fever today and was buried ashore.

May 1: Nelson and King watering ship today. Rest of party ashore collecting. Williams and I going up the trail leading to Santo Tomas. Hunter brought in two flamingos he shot on a lagoon to the westward of the settlement. Fine, warm day with E.S.E. winds.

May 2: Nelson and King watering ship all day. Williams and I went to a small grove of banana trees about a mile inland and spent the day collecting. This afternoon we took on 15 bunches of bananas and some chocolate Beck purchased from Don Antonio Gil. Fine weather with E.S.E. winds.

May 3: Finished watering ship this morning and took on several sacks of atoyas, some coffee and some sulphur for fu-

1906

migrating, the latter coming from the sulphur deposit in the crater of Vilamil Mountain. We exchanged tins of flour for these stores. A fine easterly breeze springing up, we made haste to get under way and at 1:00 P. M. weighed anchor, shaping our course for Chatham Island. The wind fell light during the afternoon and at 9:00 P. M. hauled to the north-east. At midnight Brattle Island bore N., distant 6 miles.

May 4: Opened with very light and variable winds, becoming calm towards noon, when we were practically becalmed. At 8:00 o'clock this morning Charles Island bore by compass E.N.E. and Essex Point, Albemarle Island, W.N.W. A slight current is setting us to the westward. Great numbers of tuna, the largest schools we have so far seen, keep passing by at intervals. Nelson tried fishing from the flying-jib boom and succeeded in hooking a large one, which carried away the line and got away. King tried to harpoon one, but the shaft of the harpoon bent and he also lost his fish. Beck and Gifford went out in the skiff shooting birds. Still calm at nightfall.

May 5: Opened with a faint breeze from the eastward. Hauled the schooner on the wind, steering full and by. Big schools of tuna about the schooner most of the day. Nelson tried hooking one from the flying-jib boom and finally succeeded in getting hold of a big fellow. He slacked up the line till we got the fish alongside amidships, when we got a running bowline around it and hauled it on board. It measured five feet four inches in length. On opening up the stomach, it was found to contain the remains of small crabs. The cook cut some steaks off for supper and they proved to be excellent eating. The flesh was a little dry, but solid, and, quite tasty. Williams tried harpooning one from the martingale stay, but he had the same experience as King, the shaft of the harpoon bending when it struck the fish. After supper this evening, Nelson hooked two more tuna, but they straightened out the hooks and got away. Our stock of bananas is all starting to ripen at once, so we are feasting on them for the time being. Had the skiff out again this morning shooting birds and Beck brought in a number of shearwaters. Lat. $1^{\circ} 56' S.$, Long. $90^{\circ} 46' W.$ at meridian.

1906

May 6: Opened with very light unsteady breezes from the southeast. A light fog during the night. Schooner making little headway. Tuna still about the vessel, but in greatly reduced numbers. Tried fishing off the flying-jib boom again, but with no success. Weather quite cool. Lat $2^{\circ} 35' S.$, Long. $90^{\circ} 32'$ at meridian.

May 7: Opened with very light easterly breeze followed by calms. At 8:00 A. M. the wind hauled to E. by S. and we tacked ship. Wind continued light throughout the day and at 8:00 P. M. hauled around to N.N.W. It remained light throughout the night and we had considerable southeast swell. Lat. $2^{\circ} 52' S.$, Long. $90^{\circ} 22' W.$ at meridian.

May 8: Opened with light unsteady winds and heavy swell from the southeast. Had a light rain during the morning. Nelson caught two fine tuna from the flying-jib boom. We watched the tuna chasing flyingfish. They would jump clear out of the water, catching their prey just as the fish would hit the water on the downward plunge. Beck and Gifford out in the skiff this morning shooting birds. Lat. $2^{\circ} 29' S.$, Long. $90^{\circ} 4' W.$ at meridian.

May 9: Opened with light winds, cloudy weather and a heavy swell from the southeast. At 11:00 A. M. the main boom-tackle carried away and we lowered all sails, except the foresail, to prevent wear. Beck and Gifford out in the skiff this morning to collect birds. Nelson and I rove off a new boom-tackle and repaired a rip in the mainsail. We set all sails again at 6:00 P. M., when a light breeze from the southeast sprang up. At 9:00 P. M. it hauled to the northward. The sky cleared this afternoon and we had sun a good part of the time. Schools of tuna still with us. Our bananas are ripening faster than we can eat them, so the cook made banana pie for supper. Lat. $2^{\circ} 23' S.$, Long. $90^{\circ} 08' W.$ at meridian.

May 10: Opened with light breeze and calms, continuing the same throughout the day. Beck had the skiff out this morning collecting birds. Tuna and bonitas in great numbers about the schooner. Williams tried fishing from the flying-jib boom and caught a fine bonita. King tried his luck with the harpoon and this time struck a fine tuna, the harpoon

1906

going clean through the fish. At 6:00 P. M. the wind hauled to the eastward, the heavy swell from the southeast still continuing. Lat. $2^{\circ} 08' S.$, Long. $89^{\circ} 49' W.$ at meridian.

May 11: Opened with fine weather, light and unsteady winds. The southeast swell seems to be moderating some. Beck went out in the skiff this morning collecting birds. Williams and King tried their luck at fishing again, but met with no success. Fresh fish is always welcome on the mess table. As Chatham Island is still a long way off and there are no immediate prospects of getting there, Beck decided to try and make Hood Island. Lat. $1^{\circ} 51' S.$, Long. $89^{\circ} 40' W.$ at meridian.

May 12: Opened with light airs and calms. At 10:00 A. M. Hood Island was sighted and at noon it bore by compass NE. by E. $\frac{1}{2}$ E., distant 17 miles. A check on our chronometer showed it to be 50" slow since April 22nd. At 6:00 P. M. Hood Island bore E. by N. $\frac{1}{2}$ N., distant ten miles. The large school of tuna which had been passing the schooner disappeared this morning, but we sighted it again this afternoon. Calm weather most all the day. Lat. $1^{\circ} 32' S.$, Long $89^{\circ} 50' W.$ at meridian.

May 13: Opened with dead calm. A heavy fog which had been hanging over us during the night cleared a little towards noon and at 12:30 P. M. we sighted Gardner Island (near Charles), bearing by compass E. $\frac{1}{4}$ S. Lat. $1^{\circ} 21' S.$, Long. $90^{\circ} 8' 30'' W.$ at meridian. At nightfall it was still calm and the fog shut down on us again.

May 14: Still calm. The fog cleared at 6:00 A. M. and we sighted Caldwell Island, bearing by compass S., and Enderby Island bearing NW. A light breeze springing up brought us abeam of Enderby Island, and, after breakfast, a shore party landed, while the schooner laid off and on. We found nothing much on the island but boobies and countless numbers of frigate-birds. After spending an hour or so ashore, we all hurried back on board the schooner to take advantage of a good southerly breeze which sprang up and set course for Black Beach Roads, where we arrived at 1:15 P. M., letting go anchor in seven fathoms of water. Here we found the brigantine *Nellie* at anchor and was informed by

1906

her captain he had been 67 days out trying to make Guayaquil. Bad luck seemed to follow the vessel and they struck long periods of calms and head winds. The *Nellie* was equipped with a small wood-burning engine, but fuel gave out and she drifted far to the south of the islands. Water and provisions also gave out and it became necessary to condense water, and fish and catch turtles when possible to supply the passengers and crew with food. Yesterday morning they were becalmed off Charles Island with sails torn and ruined. The cattle they were trying to carry to Guayaquil had long since died and were thrown overboard and for the past week all hands had been living on molasses, not having been able to catch either fish or turtles. Besides the crew there are 19 passengers, one of whom is a woman. This morning they reached Charles Island and started gathering firewood for the boiler. The engineer was ashore with three dogs, a couple of sailors and a young man named Cruz, who was born on Charles Island some 20 years ago. Cruz guided them up to the spring, where the engineer, who had a long knife lashed onto a boathook, was going to try and stick a pig. After securing the schooner, Nelson, Ochsner, Hunter and myself started inland for the spring prepared to stop over night and bring out some fresh beef. We met the hunting party from the *Nellie*, who up to the present had no luck in their quest for a "porker." We shot a bull for them, which they carved up, and, with all the meat they could pack, the party made tracks for the beach.

May 15: In camp with Nelson and party at the spring. Last night we shot a pig and two cows. A shore party from the schooner brought the meat down this afternoon. Nelson, Ochsner and myself are going to stop over another night. The captain of the *Nellie* shifted his anchorage this morning and moved closer inshore. Some of his passengers landed to gather oranges and lemons for the voyage back to Vilamil. Beck provided the vessel with some provisions from our own stores and she sailed at midnight. At 5:00 o'clock this afternoon, while we were taking an observation from our lookout above the spring, we sighted a barque bound to the westward.

May 16: Nelson, Ochsner and myself still in camp. We were up at daybreak and shot a large boar from our lookout

1906

station above the spring. We also killed a cow last night and the shore party from the schooner helped to pack down the meat. Everybody aboard the schooner for supper this evening. If we have any wind in the morning Beck intends to move down the coast towards Cormorant Bay.

May 17: All hands up for early breakfast. At 7:00 A. M. we weighed anchor and set sail for Cormorant Bay. We made the anchorage at 9:00 o'clock and all hands landed for general collecting, Williams and I going to a small, rocky islet in the bay to get some cactus for the live tortoises we have on board. Everybody returned at 11:30 and we weighed anchor again, setting sail for Chatham Island. The wind fell light during the afternoon and at 6:00 P. M. Charles Island bore by compass SW. by S. $\frac{1}{2}$ S. and Gardner Island S. At 11:00 P. M. we were becalmed.

May 18: Opened with light airs and calms. Weather partly hazy. Went out in the skiff with Beck this morning to shoot birds. The current is setting us to the westward and at 8:00 A. M. Barrington Island bore by compass NE. by E. and Charles Island SW. by S. Unsteady breezes and spells of calm during the afternoon and evening.

May 19: Opened with light airs and calms. Current is setting us W.NW. Went out in the skiff again this morning shooting birds. Williams and King breaking out coal for the galley. When we left San Francisco, our supply of coal for the galley was stowed in sacks underneath the cabin floor, and these having long since rotted away, left it in bulk, which made it necessary to get down under the cabin floor on hands and knees and dig it out, passing it up in buckets through a small hatch. We all take a turn at this. The wind died out towards evening and at nightfall we lay becalmed. At midnight Nameless Island bore by compass N.NW., distant eight miles.

May 20: Becalmed with somewhat hazy weather. All hands keeping the Sabbath. Our position scarcely changed, and at midnight Nameless Island bore by compass N., distant 5 miles.

May 21: Still becalmed with a few catspaws from different directions during the day. Went out in the skiff with Beck

1906

shooting birds. Williams tried harpooning some sharks which were swimming about the schooner, but they were too deep down and he failed to land one. One albatross sighted this morning. At 9:00 P. M. we got a slight breeze from the eastward and stood S.S.E. on the port tack.

May 22: Opened with light easterly winds and hazy weather. At 6:00 A. M. Nameless Island bore by compass N. by W., distant 12 miles. Towards evening the wind hauled north and at midnight we were about five miles off of Charles Island, the main peak bearing by compass SE. by E.

May 23: Opened with light variable winds and calms. Weather slightly hazy. During the morning we worked up towards Black Beach Anchorage and got in close to shore, about one mile to the westward, when we had to let go the kedge, as the wind died out and we were drifting too close in. We hung on with the kedge till 11:30 A. M., when, under a slight breeze, we weighed anchor and worked up to Black Beach, letting go anchor in 7 fathoms of water at 1:15 P. M. After securing the vessel, Nelson, King and Ochsner went up to the spring to camp for the night. Rest of the party collecting about the lower levels. Beautiful sunset this evening, the sun going down directly over Iguana Cove Mountain.

May 24: All hands aboard the schooner up for early breakfast. Beck, Stewart, Williams, Gifford and myself started up for the spring. We met Nelson, and later Ochsner, neither of them having secured any fresh meat. Later on in the morning, Nelson shot a cow, and he, Williams and myself, loaded with meat and oranges, went down to the landing, arriving there at 2:00 P. M. Nelson and I loaded up with provisions and started back for the spring, again prepared to stop over night. Hunter shot a calf this afternoon and Stewart and Gifford brought the meat down to the schooner, where Parker tried his hand at salting it down. Dead calm during the 24 hours.

May 25: Slight northerly breeze this morning, followed by calms this afternoon. All hands ashore collecting, returning to the schooner for supper.

May 26: Went up to the spring with Williams and King; the latter, taking the rifle, went hunting and killed two bulls.

1906

After a lunch of oranges and water at the spring, Williams and I worked over towards the main peak, returning to the schooner at 5:30 P. M. Rest of party worked on board the schooner all day, scrubbing off the sides and preparing to fumigate the holds and cabin over night, as the bedbugs, cockroaches, flies and dermestes were getting too thick for comfort. After supper, the pans of sulphur were lighted, the hatches battened down, and the companion ladder doors closed and caulked. All hands turned in on deck.

May 27: Opened up the hatches at 8:00 A. M. this morning and found that the sulphur had not all burned out, and that, although there were many dead cockroaches and flies scattered about, the bedbugs were as good as new. We had breakfast at 10:00 A. M. in the sulphur-scented cabin. At 4:30 P. M. Nelson, Ochsner and myself started up for the spring prepared to stop over night. While in camp this evening, a huge meteorite, making a bright bluish light, passed through the heavens, illuminating the whole sky for a few seconds. The dead calm still continues.

May 28: Nelson, Ochsner and myself still in camp. King joined us this afternoon and brought us in some supplies. The four of us stayed up all night waiting to get a shot at a pig and were rewarded by killing a large boar which came to the spring to get a drink. Towards midnight, while Ochsner and I were sitting under an orange tree close by the spring, we heard an animal approaching, and, as it came nearer, we could hear it sniffing our trail and knew that it suspected all was not right. Suddenly a huge boar came into view close to the end of a rock wall by the water. Ochsner raised his rifle and put a bullet through both its hind legs. Despite the fact that the boar was completely broken down behind, it managed to drag itself 50 or 60 yards into the heavy brush. We followed in a little way, but were afraid to get too close, fearing it might charge. However, when our eyes became accustomed to the darkness we could see the outline of the boar sitting on his haunches and advance close enough to hear him gnash his teeth. Another shot from a small carbine I carried finished him. As we had no lights, except our camp candles, we waited till morning to examine our prize. It proved to be the largest

1906

boar we had so far killed. The rest of the party collecting about the lower levels. The calm still continues and we are all hoping for a wind so we can move on.

May 29: All hands but Beck ashore for half a day's collecting. We returned to the schooner at 1:00 P. M. for dinner and at 2:30, taking advantage of a fresh breeze from the S.S.E., weighed anchor and set sail for Chatham Island, with the intention of going around the west end of Charles. It fell calm at 4:00 P. M. and the kedge was let go in 26 fathoms of water, saddle point on Charles Island bearing by compass SE.

May 30: Calm all through the night, with light fog between 6:30 and 9:00 P. M. About 6:00 A. M. a light breeze from the southward sprang up and we hoisted the kedge. However, it soon turned calm again and we drifted back to Black Beach Roads, letting go anchor at 4:00 P. M. in 7 fathoms of water. Had early supper, and Beck, Nelson, Ochsner, King and myself went up to the spring to camp over night.

May 31: A light breeze sprang up after sunrise and Williams and I went up to the top of the highest peak to have a look around. There was a good breeze on the summit and some breeze on the ocean to the eastward, but everywhere else it was a dead calm. Williams returned to the schooner, while I went back to the camp for another night. Nelson had shot a cow and the shore party took fresh meat back to the schooner.

June 1: Light airs and calms at the anchorage. Williams went up to the top of the highest peak again to have a look around and found the ocean calm all about the island. I returned to the schooner at noon and then went back up the trail to help Nelson pack down a load of meat. All hands, with the exception of King and Hunter, who went up to camp over night, on board for supper.

June 2: Foggy and calm this morning. After breakfast at 6:15, Ochsner and I started up for the top of the high peak. Some of the party working on board today, Gifford taking a turn at filling the coal box. Williams and King left

1906

for the spring this afternoon to go on a pig hunt. They saw several pigs during the course of the evening and killed one. On reaching the plateau near the divide between the main peak and the spring, they saw a large band of wild burros, which stampeded on their approach. Leaving the spring at 9:15 P. M., they made their way down the main trail and headed for the beach, arriving there at 11:30 P. M. Gifford shot a couple of owls on the way down. Nelson and White left for the spring this afternoon to stay over Sunday and do some hunting. King and Williams slept on the beach tonight.

June 3: Light variable winds and calms. At 8:00 o'clock I went in with the skiff and picked up Williams and King. Beck and Hunter doing the cooking while White is ashore. About noon, the sloop *Tomasita*, of Albemarle, dropped anchor alongside of us. She was eleven days out from Guayaquil. Her captain reported that it took him three days to get out of the Gulf of Guayaquil on account of the light winds. He had nothing else to report except that he sighted the brigantine *Nellie* yesterday headed for Albemarle Island. The crew of the sloop went ashore to gather oranges and lemons soon after the anchor was down. Nelson and White still up country.

June 4: White returned from the interior this morning and reported killing one pig, while Nelson killed a couple of bulls. The *Tomasita* left at 10:00 o'clock this morning, bound for Vilamil. The *Nellie* was in sight to the north of Charles this afternoon. All hands aboard this afternoon, and at 2:30 P. M., under a fresh southeast breeze, we weighed anchor and set sail for Hood Island. At 6:00 P. M. the breeze died down and by sundown it was dead calm. At nightfall Saddle Point bore by compass NE. by E., distant 5 miles.

June 5: Opened with dead calm. Later in the morning a light breeze sprang up and the schooner was headed east. At 8:00 o'clock the center of Charles Island bore E. by N. $\frac{1}{2}$ N., distant 30 miles. At noon it bore E. by N., distant 25 miles. The current is setting us to the westward at the rate of about one mile per hour. Considerable swell running from the south. During the afternoon a light southeast breeze brought us to within twelve miles of Charles, the center of the island bear-

1906

ing E. by N. At 6:30 P. M. the schooner was put on the starboard tack. It remained calm all night, the schooner's head being between S. and SW. without steerage-way. Lat. $1^{\circ} 21' S.$, Long. $91^{\circ} 01' W.$ at meridian.

June 6: Opened with calm and light unsteady breezes. A heavy swell from the S.S.E. makes it hard on the sails and running rigging. A few tuna seen today, but we failed to catch any. At 6:00 P. M. the wind hauled to the eastward and the schooner was put on the port tack. Beck had the skiff out this morning and shot a number of birds. Lat. $1^{\circ} 44' S.$, Long. $91^{\circ} 21' W.$ at meridian.

June 7: Opened with light unsteady winds and cloudy weather. Heavy swell from the southeast still continues. Went out with Beck in the skiff and got some more birds. A small shower passed over us this evening. We are unable to make any headway and are drifting further and further away from Hood Island. Lat. $2^{\circ} 31' S.$, Long. $92^{\circ} W.$ at meridian.

June 8: A fresh southeast breeze sprang up this morning, but died out towards noon. Heavy southeast swell playing havoc with the sails and running rigging, as there is not enough breeze to keep the sails full. At 6:30 P. M. we lowered the mainsail for repairs, hoisting same at 8:30. A strong current is setting us to the westward. Lat. $3^{\circ} 36' S.$, Long. $92^{\circ} 59' W.$ at meridian.

June 9: Opened with light breeze from the E.S.E. Sky partly cloudy. This morning we sighted what we took to be a large killer whale. At 1:00 P. M. we tacked ship, and again at 4:00 P. M. Lat. $3^{\circ} 28' S.$, Long. $92^{\circ} 45' W.$ at meridian.

June 10: Opened with light unsteady breezes, turning to calm at sunrise and remaining so for the rest of the day. Williams caught several bonitas while fishing off the flying-jib boom. Sighted a huge whale this morning. Heavy swell keeps up all the time and makes life on board anything but pleasant. Our sails and running rigging are in a bad way. Lat. $4^{\circ} 23' S.$, Long. $93^{\circ} 12' W.$ at meridian.

June 11: Opened with light variable breezes which freshened towards evening. Went out in the skiff this morning with Beck shooting birds. Quite a number of shearwaters

1906

and petrels about. Williams went fishing off the flying-jib boom and caught several fine bonitas. We find them quite a help to our bill of fare. Lat. $3^{\circ} 42' S.$, Long. $92^{\circ} 22' W.$ at meridian. A little northerly made during the last 24 hours.

June 12: Opened with light breeze from the southeast and then turned calm. Williams caught some more bonitas this morning. Members of the expedition variously employed mending shoes, clothes, etc. At 5:00 P. M. we lowered the mainsail for repairs, also hauled down the head sails and clewed up the gaff topsail. Lat. $3^{\circ} 07' S.$, by observation, Long. $91^{\circ} 29' W.$ by dead reckoning at meridian.

June 13: Opened with light southeast winds, increasing towards evening. Swell moderating to some extent. Nelson busy painting the skiff and Hunter and I made a new piece of pipe for the galley smokestack. Fresh bonita for dinner is the only good thing which comes to us in these days of calms. Lat. $2^{\circ} 39' S.$, by observation, Long. $90^{\circ} 58' W.$ by dead reckoning at meridian.

June 14: Opened with light southeast winds and moderate swell from the E.S.E. This morning sighted a frigate-bird, a booby, and an albatross. At 10:00 A. M. the schooner was put on the port tack and we made about E. by N. Nelson and Ochsner busy repairing and painting the skiff. Beck and I went out in the ship's boat shooting birds. Towards evening, the sky clouded up and we had a few drizzles. At sundown it turned calm and remained so throughout the night. We are now over a hundred miles south of Hood Island. Lat. $2^{\circ} 22' S.$, Long. $90^{\circ} 46' W.$ at meridian.

June 15: Opened with light breezes and calms. Williams caught another bonita this morning. At 5:00 P. M. we lowered the mainstail for repairs, hauled down the head sails and clewed up the gaff-topsail. All hands, except Nelson and myself, turned in, as the schooner was becalmed and had no steerageway. We turned to and repaired the mainsail, finishing up the job at 10:00 P. M. We turned all hands out at 4:00 A. M. to make sail. Still calm at daybreak with the current setting us to the westward. Lat. $2^{\circ} 10' S.$, Long. $90^{\circ} 43' W.$ at meridian.

1906

June 16: Opened with dead calm. At 10:30 A. M. a fine southeast breeze sprang up and sent us along at 5 knots, making about E. The wind died down in the afternoon and at 6:30 we were making E. by N. under a light breeze. Sky overcast and light showers during the evening. Some fine, large bonitas sighted this afternoon, but we failed to catch any. Lat. $2^{\circ} 11' S.$, Long. $90^{\circ} 53' W.$ at meridian.

June 17: Opened with light easterly winds and calms. Tacked ship this morning, going on the port tack and making little better than S. $\frac{1}{2}$ E. Sky overcast and threatening, but no rain. No birds or fish sighted today. The sails and running rigging are being badly worn by the long calm and heavy swells. Lat. $2^{\circ} 41' S.$, Long. $91^{\circ} 26' W.$ at meridian.

June 18: Opened with dead calm and overcast sky. Heavy southeast swell running. At 11:30 lowered the mainsail and hauled down head sails. Went out this morning in the ship's boat with Beck shooting birds, returning to the schooner at noon with some petrels and shearwaters. This afternoon helped Nelson repair the mainsail and gaff-topsail, the latter being badly torn. Hoisted the mainsail at 5:00 P. M. in a dead calm. Current setting us southwest about one mile an hour. Lat. $3^{\circ} 10' S.$, Long. $91^{\circ} 56' W.$ at meridian.

June 19: Opened with light breeze and overcast sky. Making a little better than E. by N. Sighted a big school of dolphins just before daybreak. Nelson caught a bonita this morning, the first in a couple of days. At sunset the schooner was becalmed. We tacked ship twice during the day in order to take advantage of the catspaws, but we are not able to make any northing. Lat. $3^{\circ} 04' S.$, Long. $91^{\circ} 37' W.$ at meridian.

June 20: Opened with light unsteady winds and occasional rain squalls. A southeast wind, increasing towards noon, sent us along at 5 knots, making about E. by N. Williams caught a fine, large bonita, which we had for supper. At 5:00 P. M. the schooner was logging seven knots. Lat. $2^{\circ} 28' S.$, Long. $90^{\circ} 58' W.$ at meridian.

June 21: Opened clear and cool with light southeast winds. Heavy swells from the southeast make the schooner roll considerably and damage our already worn out sails. Schooner

1906

making about four knots E. by N. We keep tacking the schooner to take advantage of the breeze. Lat. $2^{\circ} 03' S.$, Long. $90^{\circ} 31' W.$ at meridian.

June 22: Opened clear and cool with fair sailing breeze. Schooner logging about four knots and making E. by N. At 6:00 A. M. Hood Island was sighted, bearing by compass NE. by N. The breeze continued during the afternoon and raised our hopes of getting back to the island. At 5:45 P. M. we lowered the mainsail to repair a slight rip. Breeze still holding good at nightfall.

June 23: Opened with fine sailing breeze and at 7:30 we were about eight miles off Hood Island. Great numbers of albatrosses, shearwaters, gulls and frigate-birds flew about the schooner as we skirted the south shore of the island. At 2:00 P. M. we rounded the northeast end and let go anchor in Gardner Bay. We had been 19 days at sea and were glad to get back where we could get to hunting on shore again. King and Williams helped Nelson unbend the mainsail and break out an old foresail to repair it. The rest of the party went ashore collecting. Ochsner going after some goats. Shore party returned at 5:45, bringing a goat and a number of birds. Being Saturday night, the ornithologists skinned birds till late in the evening. Everybody glad to get a run ashore and get some fresh meat after our long sojourn south of the islands. Sky overcast and weather cool this evening. Most of us wearing coats or sweaters.

June 24: Late breakfast, today being Sunday. Most of the party taking a run ashore. Ochsner and myself went after fresh meat and brought back two goats and 49 doves. Gifford and Williams went trapping birds, bringing back several mockingbirds. All hands aboard for supper at 6:30. Sky overcast and weather warmer today.

June 25: Nelson and Parker busy repairing the mainsail. Rest of party went down to the albatross colony. Great numbers of albatrosses, many with young, were about the colony at this date. Early in the afternoon we started back for the schooner loaded down with albatrosses, frigate-birds, tropic-birds and boobies. Ornithologists making up for lost time

1906

and skinning birds far into the evening. Goat soup and dove pie for dinner. Weather partly cloudy with southeast winds. Occasional showers during the evening.

June 26: Beck, Hunter, King and Gifford on board skinning birds. Rest of party ashore collecting, Williams bringing in three snakes and an owl. King and Hunter went ashore this afternoon and killed a couple of sea-lions for the hides. While Ochsner and I were chasing a goat we had wounded, we ran right over a small tortoise, the first living one found on Hood Island for many years, so we were quite elated over our find. We took turns at packing it out alive, as it was only a small one. Nelson and Parker still working repairing the mainsail. Warm and drizzly weather today.

June 27: Beck, King, Ochsner and myself ashore in search of tortoises. Stewart and Williams went over to Gardner Island. Hunter on board, cleaning seal hides and skulls. King was the only successful tortoise hunter. He found a small female, which he packed down to the beach alive. The bird bodies thrown overboard by the ornithologists attracted a lot of sharks about the schooner and Williams harpooned one, but it got loose from the harpoon and escaped. Sky overcast and weather somewhat sultry.

June 28. One year out from San Francisco today!! All hands, except Parker and Nelson, who are still working on the mainsail, ashore collecting, Ochsner visiting Gardner Island. Ornithologists made another visit to the albatross colony, bringing back about 20 albatrosses as well as some frigate-birds, boobies and tropic-birds. One goat brought aboard for fresh meat. Warm and sultry weather with southeast winds throughout the day.

June 29. Ornithologists busy skinning albatrosses. King and I went inland after tortoises, but did not locate any. We had better luck with snakes, securing several. Ochsner killed three large sea-lions and he and Williams spent the day trying out the fat. They managed to get about five gallons of oil. We find it good for oiling shoes and anything we have in the way of leather. The daily goat for the mess was brought on board by the shore party. Late supper this evening in order

1906

to give the ornithologists a chance to finish up the birds. Cloudy weather with southerly winds.

June 30: Ochsner and Stewart, trying out seal fat, got about five more gallons of oil. Williams, King and myself inland after tortoises, but did not find any. We killed about 30 doves and brought them back for the mess. Beck found a few remnants of tortoise bones near the top of the island, but saw no signs of living tortoises. Nelson and Parker working on the mainsail. Cloudy weather with southerly winds and some light rains during the early part of the evening.

July 1: Late breakfast, today being Sunday. In the afternoon went ashore with Ochsner, King and Gifford to get some doves for the mess. We returned to the beach at 6:00 o'clock, Ochsner and I with 25 doves and a goat and Gifford and King with 20 doves between them. Williams put a live mockingbird in the fore hold and the bird at once made itself at home and began to clean up some of the dermestes which infest the vessel. Late supper of doves, goat and pumpkin pie this evening. Occasional showers today.

July 2: All hands ashore for another day's work on Hood before we sail. Beck ashore photographing and hunting for tortoises and a party visiting the albatross colony again. Nelson and Parker finished up their work and bent the mainsail this morning. While King and I were ashore getting a supply of cactus for the tortoises on board, we met Beck returning to the landing with a small, live tortoise, the third we have found on Hood. This afternoon a big tiger shark came up alongside the schooner and grabbed a goat hide which had been thrown overboard. Before turning in this evening, Williams bent a sharp hook, baited with a bird body, on to the end of a boat fall and let it stay overboard all night in hopes that the shark would come back and pay us another visit. A rather disagreeable day today, drizzly and windy.

July 3: All hands up early and we prepared to get under way. We found that a big shark had gotten hooked on the boat fall and, from the way it was twisted and turned, it looked as if the big fish had been struggling most of the night to free itself. Being too large to handle readily, a line was

1906

made fast around its tail and we hoisted it on board with the winch. It measured 13 feet in length and its stomach was found to contain several bird bodies thrown overboard by the ornithologists. After cutting off the tail and taking the jaws out to dry, we heaved the remains overboard and got under way for Chatham Island with a fine sailing breeze from the southeast. At 3:30 P. M. we made up to the anchorage in Wreck Bay, letting go anchor in five fathoms of water. Beck, Williams and Ochsner went ashore to take some turtle and goat meat to the plantation manager. At 7:30, Hunter and Stewart returned with a load of letters and papers and we learned for the first time some of the details of the San Francisco fire and earthquake. Letters from home told us of our families being safe and everybody read papers till late in the evening. Cloudy weather and fresh southerly breeze throughout the day.

July 4: Hoisted our colors at eight bells in honor of Independence Day. Received visitors and read papers most of the day. We learned from Captain Levic, of the Chatham sloop, that some meat which Beck had ordered to be sent from San Francisco via Guayaquil had not arrived and that we could get nothing but dried meat at the latter port. This will make us short of meat on the homeward voyage. Our visitors left the schooner late in the afternoon. Cloudy weather with fresh southerly breeze.

July 5: Ochsner went up to the hacienda to attend a wounded man who had accidentally been shot when one of the peons was trying to force a cartridge into a revolver. We learned later that some of the peons had stolen a revolver off of a visiting ship and had planned to kill the Governor. They had a few odd cartridges and it was while trying to find one that would fit the gun that the accident happened. The Governor and the plantation owner never go about unarmed. Williams, Stewart and Hunter went up to the hacienda with equipment and supplies to camp overnight in the interior. They secured the services of a negro guide and started off to explore some of the small crater lakes on the plateau near the summit of the island. The party had a rather wet and miserable time of it and did not secure much in the way of

1906

specimens. Bird life seems to be rare at the higher elevations and there are no reptiles at all. Nelson sent down the maintopsail and worked on same all day. Cloudy weather most of the day with light southeast winds and a few showers.

July 6: Went up to the hacienda and found Ochsner with his patient, who had a slight flesh wound, progressing satisfactorily. Party from the interior arrived at the hacienda about 5:00 P. M. Some of the Jamaican negroes brought us a lot of fine bananas, the first fresh fruit we have had for a long time. All hands made for the beach about 6:00 o'clock and arrived on board the schooner for late supper. Nelson finished working on the maintopsail today. Cloudy weather with fresh southeast winds and some showers.

July 7: All hands ashore collecting. A new pipe for the galley stove, made by the blacksmith at the hacienda, was brought on board and fitted today. The Governor paid us a visit this afternoon and some of the peons brought us down oranges and bananas. After supper, Williams and I went ashore collecting with a light and secured some lizards and insects. Nelson bent the maintopsail, cleaned off the waterline, and got the vessel ready for sea. Cloudy weather with southeasterly winds.

July 8: Late breakfast, today being Sunday. Many visitors on board and extra shoes and clothing from our personal belongings were sold to some of the men from the hacienda. They are most anxious to get shoes and overalls. Captain Levic, of the Chatham sloop, presented us with five live chickens. A mockingbird, which we had on board, got into the lazaret, where it got mixed up in a pan of dough and sunk to the bottom in its struggles for freedom. Beck took our letters for home on shore after supper, as we hope to get under way early in the morning. At 10:00 o'clock this evening the sloop *Josephine Cobos* entered the bay and dropped anchor. Cloudy all day with fresh southerly breezes.

July 9: All hands turned out at 4:15 and, after coffee, we weighed anchor and set sail for Barrington Island, getting under way at 5:00 A. M. We had a light but fair breeze and made up to the anchorage off Barrington at 10:45,

1906

letting go anchor in 15 fathoms of water. Our anchorage is off a nice, sandy beach with a great number of sea-lions scattered along it. Collecting parties landed at once, Hunter going after some goats for fresh meat. Beck found some fragments of tortoise bones and Nelson a couple of old eggs buried in the earth. The iguana colony has evidently suffered from a visit made by the fishing sloop from Chatham, as the iguanas are quite scarce compared with the numbers found on our former visit. We are only able to secure a few this trip. All hands got back late this evening for 7:00 o'clock supper. Had the chickens Captain Levic gave us for supper, the first we had tasted since leaving San Francisco. Weather cloudy with fresh S.S.E. wind. A strong current sweeping around the end of the island keeps the schooner riding to a taut chain.

July 10: Brigantine *Nellie* sighted to the northward, probably bound for Vilamil. All hands ashore doing general collecting. Ochsner and King shot three goats, which are much poorer looking than those of Hood Island. We tried some land iguana for supper this evening, but it was not considered a great success. All hands aboard for supper at 6:00 o'clock. Fresh winds from S.S.E. and cloudy weather with showers during the morning. A somewhat heavy swell today and the schooner rolls considerably.

July 11: All hands up for early breakfast. At 7:15 we weighed anchor and set sail for Academy Bay, Indefatigable Island. Had a fair breeze and made up to the island at 11:30 A. M. In working up to the anchorage under a very light breeze, we got in a little too close and touched on the sandy bottom. The kedge was put out and we hauled the schooner out a little, letting go anchor in $2\frac{1}{2}$ fathoms of water. After lunch, Gifford started up for the green zone prepared to camp over night. Rest of the party collecting about the waterhole, washing clothes and doing odd jobs about the vessel. Took on one barrel of water this afternoon. Mosquitoes are somewhat troublesome this evening. Partly cloudy with light southerly winds.

July 12: Went up to the higher levels with Beck and King to look for tortoises. We found one good-sized male and

1906

started skinning operations at once. Rest of the party, with the exception of Gifford and Williams, who went up towards the green zone, collecting about the beach. King and I got the tortoise skinned out about noon and, with the help of Beck, started packing it down to the coast. On the way down, we met Gifford and Williams, the latter helping us with the tortoise. We reached the landing at 6:00 P. M. Nelson took three barrels of water on board today. A few mosquitoes aboard this evening. Fine weather with light southeast winds.

July 13: After breakfast, shore party landed to gather up washing and shoot a few birds, returning to the schooner at 9:00 o'clock. We then hove short and hoisted the sails waiting for a chance to get to sea, as the wind was very light. A little later the anchor was hoisted, but, as the breeze was too light to give steerage way and the schooner was drifting dangerously close to a reef, it was let go again. Put out the kedge and hauled the schooner away from the reef, letting go anchor again. We then lowered the ship's boat and hove up anchor. With six men in the boat, we tried to swing the schooner's head and tow her out towards the entrance of the bay, but could make no headway, so let go anchor again. After lunch we made two hauls with the kedge, but, as there was not enough wind for steerageway, the anchor was let go, the schooner being about $\frac{1}{4}$ of a mile from the anchorage. No wind up till sundown, so after supper we lowered the sails and made them fast. Everybody taking a rest after a day with the anchor and kedge. Dead calm at nightfall.

July 14: All hands turned out early. Dead calm with sky overcast. Beck and Williams went ashore for a couple of hours, King holding the skiff for them. Another party landed after lunch, keeping close to the beach in case a breeze came up. At nightfall it was still dead calm. A little warbler that flew on board this morning is still with us and has taken up its abode in the cabin.

July 15: Still calm. The little warbler that came aboard yesterday is making itself quite at home and flying about the cabin. During meal times it hops about the table gathering up the crumbs of bread. Beck and Gifford went ashore this

1908

morning for a short time. Calm and partly cloudy at nightfall.

July 16: Dead calm and clear, warm day. Beck, Nelson and myself put off in the skiff and visited a large lagoon at the head of the bay to get some turtles. With our patent turtle hook, we managed to get eleven fine, large ones. Later in the afternoon Nelson and Ochsner went in at a good low tide and got a lot of crayfish, which the cook made into salad for supper. In the evening, Hunter, Williams and myself landed at the waterhole to hunt. We got several owls and rats, the rats going into a baited trap as we stood with a light shining on it. We returned to the schooner at 10:00 P. M. and found Nelson in the galley cooking his third installment of crayfish.

July 17: Landing party went over to the lagoon we visited yesterday and returned about 5:00 o'clock. After supper, Hunter went ashore to stay for the night and collect rats and owls. Still waiting for a breeze.

July 18: Sky overcast and very light breeze. Party went ashore in ship's boat to help Hunter launch the skiff, it being a very low tide. At 8:00 A. M. hoisted sails and weighed anchor. We tried to beat out of the bay, but the breeze died down and the anchor was let go. At 10:00 A. M. we tried once more with a very light breeze, but could make no headway. The schooner drifted too close inshore for safety, so we hauled off with the kedge, letting go anchor at 12:15 in nine fathoms of water. Made sails fast during the afternoon. Beck and Nelson went out in the skiff to shoot birds, and King and I skinned turtles. Sky cloudy with occasional light airs.

July 19: Fine, clear morning. A shore party which landed at the lagoon to forage for the mess returned at noon with a turtle, two fish and a few doves. In the afternoon another party went ashore after doves and got about 35, making 67 all together. At 2:00 P. M. all hands were recalled on board, sails hoisted and anchor weighed in another attempt to get to sea. The breeze was too light for steerage way and at 3:00 P. M. anchor was let go and sails made fast. Weather calm and clear at nightfall.

1906

July 20: All hands up for early breakfast. At 7:00 A. M. hoisted sails and weighed anchor. Made several tacks to get outside where we could pick up the breeze. It took an hour or more to get clear of the bay, and, with a moderate south-east breeze, we sailed westward along the coast of Indefatigable. Nelson and I now prepared to leave the schooner in the ship's boat and make a trip to Vilamil for the purpose of purchasing some atoyas, our stock of which was running low. We rigged up a box of sand for making a fire to heat coffee, and, with provisions, bedding and water, left the schooner at the southerly point of the island and watched her disappear to the northward as she sailed wing and wing before a fine, fresh breeze. The schooner anchored in a small cove before reaching Conway Bay, a cove described to us by Captain Levic and said to be the one from which the trail to the old settlement in the interior started. With a good sailing breeze, Nelson and I, in the ship's boat, set our course for Vilamil, south Albemarle. We stood watch and watch at the tiller, making fine time towards our destination. We reached the Albemarle coast at 7:00 P. M. just as it was turning dusk and a little too late to find the small boat entrance through the reef. We anchored just outside the breaker line and spent a rather watchful night, as we were not sure of our exact position

July 21: At daybreak we sailed through a narrow passage in the reef and up to the settlement, being greeted by Don Antonio Gil, who was much surprised at our arrival, nobody having sighted our boat. We found out that we had to wait till the following day, as there were not enough atoyas at the settlement to supply our demands. A messenger was immediately despatched to Santo Tomas with an order to bring some down. Don Antonio was much elated over our arrival and informed us that we were just in time to attend the christening of a baby whom Herr Bruger mann, the German bookkeeper for Don Antonio, was chosen to be the godfather of. From Don Antonio we understood that the event was to be quite an affair with a banquet and dance to follow. Nelson and I visited our various friends about the settlement and early in the evening Don Antonio notified us that the

1906

great event was about to take place. We were ushered into a room where about fifteen guests were seated about a table and partook of a dinner of beef, rice, wine and bread, baked especially for the occasion. Music was furnished by one of the natives playing on a guitar made by the local blacksmith out of discarded oil tins. After dinner, the floor was cleared and the infant brought in to be baptized. Herr Brugermann performed the ceremony with much gusto and one of the guests yelled: "Viva la Padrino," which meant that the said godfather was to pass around some wine. The baby was rushed out of the way and the wine passed around while the dancing began. This order of ceremonies was continued till late in the evening, the orders for wine coming so thick and fast the supply gave out. When the fiesta ended, Nelson and I retired to the boat and turned in. While we were on our voyage to Albemarle, the party aboard the schooner made a trip inland, carrying water, provisions and camp gear to last two or three days. Leaving the schooner on the morning of the 21st, they found the old trail leading up to the former settlement, as described by Captain Levic, and made camp the same evening on the edge of the green zone. Conditions here were found to be quite different from those on the south side of the island, there being no nettles and morning-glory vines, but many large trees. While the party was spending its first night in camp, many shearwaters were heard passing over and giving their peculiar cackling cry as they flew to and fro from their burrows on the mountain side.

July 22: Nelson and I turned out bright and early to await the arrival of the peon with the atoyas. He arrived about noon time and, after loading our boat and bidding adieu to Don Antonio, we started on our return journey to the schooner. Making a safe exit through the boat passage in the reef, we found a strong current against us, so that we were not able to make our course. We therefore tacked out to Brattle Island and at 11:00 P. M. anchored close to the shore under the lee of it. Making a fire in the sand box, we heated some coffee, which, with some beans and hardtack, constituted our supper. Rolling up in our blankets, we went to sleep awaiting the morning breeze. The shore party on Inde-

1906

fatigable was spending its second night in the interior, camped high up in the green zone. Early in the morning they continued their journey upward, having some difficulty keeping the trail. It became indistinct as they went upward and was often lost. At times it was found again only with the greatest difficulty and after much searching. The remains of an old camp were found, as well as some broken bottles and old tortoise bones. A shower of rain passed over the island early in the morning and soaked everybody to the skin. At noon, a halt was made by a lemon tree alongside the trail and well loaded down with fruit. By chopping into an old tree, enough dry wood was secured to build a fire and cook a meal. At this elevation there are many fine, large trees and an atoya plant was discovered, which led the party to believe they were not far from the site of the old settlement. Williams climbed up a tree to take an observation and saw in the distance a patch of banana trees and what looked to be a small grove of orange trees between two small peaks covered with a growth of agave. There also appeared to be a small crater which might have enclosed the lake Captain Levic spoke of as being on the island. At the highest point reached, Beck found a shearwater's burrow containing a bird and one egg. As further progress was impossible on account of the shortage of provisions, the party started down again, making for their former camp, which was reached at 4:00 o'clock in the afternoon. A drizzle kept up most of the night to make things more interesting.

July 23: Shore party turned out early and started for the coast, the drizzle still continuing and wetting everybody through to the skin. When the lower levels were reached, the doves became abundant and many were secured for food. About fifty were killed and fried in skillets brought along in hopes the party would get some chickens, which were reported to be about the site of the old settlement. After lunch, the downward journey was continued and doves picked up along the way for fresh meat for the mess on board the schooner. By the time the shore was reached, the party had about 100 doves, Hunter and Beck killing most of them with sticks. White, Ochsner and King were found on the beach picking

1906

doves, they having killed another hundred or so. The shore party turned in early this evening, being well tired out from their journey inland. At daybreak Nelson awoke half frozen and, arousing me, informed me that I had pulled all the blankets off of him during the night. After a 7:00 o'clock breakfast of hardtack and coffee, we got under way for Indefatigable Island. We had a light breeze from the S.S.E., which increased some during the day, and we shaped our course to the southward of Nameless Island. Nelson and I took turns at the tiller throughout the day and at 7:30 P. M. we passed Nameless Island, making the coast of Indefatigable an hour later. We then sailed northward, keeping a lookout for the anchor light of the schooner. We sighted it about three miles to the southward of Eden Island and came up to her at 10:00 P. M., finding all well on board. After relating our experiences, we turned in to a more comfortable bunk than we had in the crowded quarters of our 17-foot boat.

July 24: All hands turned out early and most of us went ashore for more doves, returning at 8:30 with about 200. We then weighed anchor and set sail for Daphne Island. Passing Eden Island, we hove the schooner to, and Nelson, Gifford and myself pulled in with the skiff and took six turtles off of the beach. Continuing on our journey, we passed Guy Fawkes Island and Conway Bay. The wind failed shortly afterwards and, being unable to make Daphne, we set our course for the north coast of Indefatigable, anchoring at 6:00 P. M. in 5 fathoms of water, with Daphne Island bearing by compass NW by N. Doves every meal now, the cook making a big pie of them and baking it in the dishpan. Partly cloudy during the day with fresh, southerly winds during the morning, turning to calm in the afternoon.

July 25: Fine, bright morning with fair breeze. Beck, Gifford and Nelson went to Daphne Island in the ship's boat, returning at noon with an assortment of land birds. Rest of party collecting about the vicinity of the anchorage. At 3:00 P. M. we weighed anchor and shaped our course for South Seymour Island, where we arrived at 4:45 P. M., letting go anchor in four fathoms of water off a long sand beach. Nelson, Ochsner, Gifford and myself went ashore to get some goats

1906

for the mess. We returned to the schooner at 6:00 o'clock, having killed and skinned four, which we turned over to the cook. Partly cloudy with light variable winds.

July 26: Landing party ashore for general collecting. King and I collected a number of land iguanas, which are quite common here. Nelson and Ochsner shot two more goats for the mess and captured two alive, Beck intending to take them over to James Island and turn them loose. All hands aboard for 6:00 o'clock supper. Slightly cloudy with light variable winds and calms.

July 27: All hands up for early breakfast. At 7:00 A. M. we weighed anchor and set sail for the north side of James Island. By 8:00 o'clock the wind died down and the schooner lay becalmed. Towards noon a light breeze sprang up and at 1:30 P. M. we passed Sullivan Bay, heaving to off Bartholomew Island. A landing party spent a short time here and we got under way again. At 6:35 P. M. we let go anchor in four fathoms of water just to the southward of Sullivan Bay, Daphne Island bearing S.E. by E. from the anchorage. The two goats we had on board both died from eating cotton and arsenic.

July 28: Beck, King and myself in after tortoises, the rest of the party collecting about the coast. King and I found some old bones and Beck some recent signs, but no living tortoises. Just to the northeastward of our anchorage, a fine lagoon extends inland for some distance. Several flamingos and some ducks were discovered on it and promptly gathered in. One flamingo was captured alive and brought on board. Cloudy weather with fresh southeast winds.

July 29: Late breakfast, today being Sunday. All hands preparing for work ashore, mending clothes, shoes, etc. Dinner at 3:30 P. M. consisting of duck, curry and rice, roast flamingo and pumpkin pie. Ochsner entertained us this evening by giving us several musical numbers on his flute. Overcast sky with fresh southeast winds throughout the day.

July 30: All hands turned out early. Started inland with Beck and King on a tortoise hunt. The country here is the roughest we have yet encountered. The lava flows are com-

1906

paratively recent and some devoid of any vegetation whatever. Having found fresh tortoise signs, Beck and King continued inland to camp for the night, while I returned to the coast. Gifford and Nelson visited Bartholomew Island, the rest of the party collecting about the vicinity of the anchorage. Hunter and Williams made a night trip to a nearby lagoon, but met with poor success. Only one rat was taken and no owls nor bats were seen. Practically no insects came to light. Partly cloudy with fresh S.S.E. winds.

July 31: All hands turned out early this morning. At 5:00 o'clock we set sails and weighed anchor to shift the schooner's berth to the lee of a small reef so as to escape some of the swell. We dropped anchor again at 6:30 in five fathoms of water. The schooner now rides more easily and the anchorage is much better. I started inland right after breakfast to pick up Beck and King and see what they had found. Locating the camp about five miles from the coast, I found King cooking breakfast and he informed me that Beck had found two large male tortoises a little further up the hill. King had one partly skinned out, so I helped him finish it and pack it back to camp. Beck was off towards the main mountain hunting for more. Nelson took the ship's boat and cruised along the coast to the westward, making landings at several places. He failed to find any signs of tortoises. Partly cloudy with fresh south-east winds throughout the day.

August 1. After breakfast, a shore party started inland to help pack out tortoises. King and I started for the coast with a large male tortoise, expecting to meet the shore party and get help from them. Owing to a misunderstanding in regard to directions, they passed us on the way without ever seeing us. They reached our camp early in the afternoon and, seeing no signs of us, started back for the coast. In the meanwhile, King and I were making the best of a heavy load over rough country and our shoulders were getting so sore, packing became difficult. We kept going as best we could till about 5:00 o'clock in the afternoon, when our shoulders were becoming blistered and raw so that we could not hold the tortoise pole on them any longer. As it was getting late, we left the tortoise on the trail and made for the beach so as to reach it

1906

before dark. The shore party, following our trail back, came across the tortoise and packed it the rest of the way out, getting down to the beach just before it got too dark to travel in safety. Being very low tide, our skiff was left high and dry up a lagoon in which we landed, so Nelson came in with the ship's boat and picked us up. During the day Beck found a couple of more tortoises and returned to camp. King and I plastered up our shoulders with cocoa butter and bandages to help get them in trim for the next tortoise to be packed out. We find the tortoises of James Island very fat and with very thick shells. Fine weather with fresh S.S.E. winds.

August 2: With Hunter, Ochsner and King started inland for our camp. We reached there about noon and met Beck, who informed us he had found two more tortoises. He guided us to these two and we skinned them both out and packed them back to camp. Nelson and Gifford made another visit to Bartholomew Island in the ship's boat. Partly cloudy with fresh S.S.E. winds.

August 3: In camp with Hunter, Ochsner, King and Beck. We turned out early this morning to skin the tortoises already found and get them back to camp. Stewart and Williams came to camp to help pack down to the coast. We got two tortoises back to camp this evening, and King, who acted as camp cook, prepared a dinner of atoyas and tortoise liver. Having arranged with the schooner to signal them at a certain time after dark so those on board could locate our camp, we climbed a small hill and set fire to the spines of a few cacti. They flared up quickly as the fire climbed towards the tops and the schooner immediately answered us with the turpentine torch. All hands turned in early so as to get rested up for tomorrow's pack. Fresh S.S.E. winds during the morning, hauling to the westward in the afternoon.

August 4: After a breakfast of hardtack, tortoise liver and atoyas, we started for the coast, packing our tortoises and camp equipment. We took the trip in easy stages, relaying each other on the heaviest tortoise. Arriving at the beach at 6:00 o'clock, we met Nelson, who came in with the ship's boat to pick us up. All hands aboard for supper this evening. Most of us slept on deck, as Nelson had fumigated the cabin.

1906

Fine weather with light S.S.E. winds, hauling to NW. in the afternoon.

August 5: All hands up for late breakfast, today being Sunday. At 9:00 A. M. Nelson opened up the hatches and found quite an assortment of dead flies, cockroaches and dermestes. Everybody resting after the hard grind of yesterday. Fresh S.S.E. winds during the day.

August 6: All hands up for early breakfast and at 7:00 A. M. we weighed anchor, shaping our course for James Bay. Had light, unsteady southeast winds during the forenoon till 11:00 o'clock, when we got from under the lee of the island. We then got a fresh S.S.E. breeze and made three tacks to work into James Bay. We made up to the anchorage at 2:30 P. M. and let go anchor in six fathoms of water. The island appears to be very dry compared to our first visit and most of the trees are leafless. Beck went up country to camp over night and Nelson went ashore after pigs. He returned late in the afternoon, not having found any. Fine weather and clear sky throughout the day.

August 7: All hands up for 5:30 breakfast so that those of the shore party who are going inland can get an early start. Hunter, Ochsner, Stewart, King and Nelson started for the interior, Nelson leaving the party about the edge of the green zone, to go on a pig hunt. Williams and I went part way up the mountain, returning to the schooner for supper. As we were nearing the coast on the return journey, we met Beck on the way back from his over-night camp, and also Nelson, who was carrying the hind quarters of a pig he had killed. Gifford collected several flamingos today and we had them fried for supper. Very little surf on the beach this time and we have no difficulty landing and getting off like we did on our first visit here. Cloudy and drizzly most of the day with S.S.E. winds.

August 8: Early breakfast again this morning. Top of the island obscured in the mist. Williams and I worked about the vicinity of the bay. Doves being quite plentiful, we brought a frying pan ashore so we could have some for lunch. We killed a couple of dozen and, with a can of fruit, had a

1906

luscious meal. At 6:00 o'clock the campers arrived from above, reporting that they heard numbers of shearwaters during the night and saw many wild burros and pigs. Nelson shot another pig today. All hands aboard for supper. Cloudy weather with a light rain during the early morning. Fresh S.S.E. winds.

August 9: All hands up for early breakfast. Beck, Hunter, Gifford and Williams went ashore for half an hour. At 7:45 we hove short and set sails. Got under way at 8:00 o'clock, shaping our course for Cowley Mountain. We made three tacks under the lee of James, the wind being rather light up to 9:30, when it set in fresh from the S.S.E. and the schooner was hauled close to the wind. This morning we shifted bow anchors to opposite sides, the starboard chain having several bad links in it and the port anchor being too heavy for ordinary use. We arrived off the coast of Albemarle about 1:45 P. M. and took in the gaff-topsail and flying-jib. As we neared the vicinity of the anchorage, the schooner made considerable leeway, and Nelson, who was standing by the anchor, called to the navigator that we were getting dangerously close to a reef. Looking to leeward, the navigator saw we were almost upon it and gave the order to put the helm hard down. In his excitement, he neglected to use the cross-tackle to haul the main boom to windward and the schooner missed stays, drifting closer on to the reef. Finding the schooner would not come about, the anchor was let go just as she struck the rocks and worked herself on to a rocky ledge. The sails were immediately lowered, and, as the sea was quite choppy, she pounded some. The chain being short, she did not hold well and the boat was at once lowered and the kedge run out with a hawser through the stern chock. By heaving on the hawser and paying out on the anchor chain, the schooner cleared with the rising tide and we saw pieces of the shoe on the keel floating away. Heaving short on the hawser, we got both boats to work and picked up the anchor and hove in the chain. Hauling out to the kedge, we let go anchor again. In trying to break out the kedge, the hawser parted and we lost it. The sails were then hoisted and, weighing anchor, we got under way again, making short tacks to get

1906

off shore. Standing in again, we let go anchor in three fathoms of water. The schooner was immediately examined for leaks, but the loss of part of the shoe on the keel and the kedge was the worst that happened. Cowley Island bears NE. $\frac{1}{2}$ E. magnetic from our anchorage. The reef we struck is about one-half a mile to the N.NW.

August 10: All hands up bright and early, and, after much discussion over yesterday's affair, Beck suspended the navigator from further duty and appointed Nelson to take his place. Being short a man to take the deck, I am to stand watch and watch with Nelson. The charts, chronometer, etc., were removed from the possession of the navigator and he is now super-cargo. This morning, the ship's boat was put out and Nelson made a search for the kedge, but was unable to locate it. Soundings taking around the schooner show only two fathoms of water and the anchorage is none too safe. Beck, King and myself started up the mountain prepared to camp over night and make a search for tortoises. On landing opposite our anchorage, we found a layer of pumice topping a small cliff and later found the pumice to extend 2,000 feet up the mountain. The ascent is very gradual for three miles or so and then becomes fairly steep. The lower levels are very barren and sparsely spotted with cacti. When the 2,000-foot level is reached, lichen-covered trees are met with and much dried grass is in evidence. This grass is over one's head and forms a cap about the crater, making it most difficult to reach, as the sharp edges of the grass cut like a razor. Finding our way blocked by this heavy growth of grass, we turned back and camped at the lower edge of it for the night. Partly cloudy today with light S.SE. winds.

August 11: The three of us turned out early and, after a camp breakfast, started out in search of tortoises. Beck worked around the south side of the crater and found an old camp where about 70 tortoise skeletons were scattered about. King and I worked around to the northward, but found no recent signs of tortoises till we were on the way back to the beach. We were well below the grass belt when we ran on to a fresh sign and worked back and forth trying to pick up the tortoise, but could not locate it. We found out afterwards

1906

that we were just below it, for, when Beck came down, he found a small tortoise a short distance from where we passed. Roughly skinning it out, he packed it down to the beach, King and I reaching the landing a short time ahead of him. Hunter spent last night ashore and got two rats and a couple of owls. Weather continues the same.

August 12: Late breakfast, today being Sunday. King and I finished skinning out the tortoise found yesterday. Members of the party variously employed in mending shoes, etc., and preparing to land on Cowley Island in the morning. Misty and cloudy with S.S.E. winds.

August 13: All hands up for coffee at 5:30 A. M. At 6:00 o'clock we set sails and weighed anchor, shaping our course for Cowley Island. At 7:00 o'clock Beck, Hunter, King and myself put off in the ship's boat while the schooner beat to windward of the island. King held the boat while the rest of us landed. Cowley Island is a broken-down crater similar to Brattle, but much smaller. As it was early in the morning, there was nothing much about and only a few birds and lizards were collected. We got off the island at 9:15, the schooner running down before the wind to pick us up. The course was then shaped for Duncan Island with a S.S.E. wind. We tacked ship at 11:30 A. M. close to the south coast of James and tacked again at 2:45 P. M. off the coast of Albemarle. At 6:00 P. M. Jervis Island bore by compass W. $\frac{1}{2}$ S. and Duncan SW. by S. $\frac{1}{2}$ S. We made several tacks during the first watch, the wind being unsteady and light. At midnight Jervis bore by compass W. $\frac{3}{4}$ N. and Duncan S. by W. $\frac{1}{2}$ W.

August 14: Tacked ship twice in the middle watch. At 6:00 A. M. Duncan Island bore by compass SW. by S., distant six miles. At 9:25 we made the anchorage at Duncan, letting go anchor in $9\frac{1}{2}$ fathoms of water. Landing party went ashore at once, Beck and Hunter going in to camp over night. I went around to the northeast slope of the crater and collected a lot of lizards and a snake, the first one found on the island. Nelson caught five large barcalau and we had fresh fish for supper. Fine weather with fresh S.S.E. winds.

1906

August 15: Beck still ashore hunting for tortoises. King and I went down to the bottom of the crater and collected lizards most of the day. Beck found seven tortoises and, on the way back to the landing, King and I packed out three, one alive and two dead. All hands aboard by 7:00 o'clock for late supper. Cool and cloudy with fresh S.S.E. winds.

August 16: All hands turned out at 5:00 A. M. We got under way at 6:00 o'clock with strong breeze from S. by E. At 7:30 we were close to the shore of Indefatigable and tacked ship, the wind hauling to S.S.E. Weather foggy up till 10:00 o'clock, when it partly cleared. We made several short tacks off the coast of Indefatigable and at 10:30 A. M. weathered Nameless Island and stood away on the port tack. The wind fell light during the afternoon and set us back towards Duncan. Tacked ship again at 4:30 P. M. At 6:00 o'clock Cape Woodford bore by compass SW. $\frac{1}{4}$ W. and East Crossman Island S. by W. $\frac{1}{4}$ W. Tacked ship twice during the first watch. Weather set in hazy with light winds from S.S.E. At midnight Nameless Island bore E. by compass, distant four miles.

August 17: Opened with light, unsteady winds and hazy weather. Made several tacks during the morning, but could make no progress against the current, which set us back on our loosing tack. At 12:20 P. M. we passed close under the lee of Nameless Island and stood in towards the coast of Indefatigable. During the afternoon, we made short tacks close to the Indefatigable coast and made about six miles to windward. At 6:00 P. M. East Crossman Island bore by compass SW. $\frac{1}{2}$ W., distant 15 miles. Weather continues cloudy with fresh S.S.E. winds, getting light and unsteady towards evening.

August 18: Opened with foggy and misty weather with unsteady winds from S.S.E. Moderate southerly swell. At 6:00 A. M. East Crossman Island bore by compass SW. by W. and Nameless Island N. by E. Tacked ship about six times this morning to take advantage of the shift of wind. The fog lifted a little during the afternoon, but closed down again towards evening. At 6:00 P. M. Nameless Island bore by compass N. $\frac{1}{4}$ W. and East Crossman Island W. by S. $\frac{1}{2}$ S.

1906

August 19: Wind and weather unchanged during the night. The schooner was kept on the wind and at 6:00 A. M. East Crossman Island bore by compass SW. by W., distant eight miles. At 9:00 o'clock we made up to the island, when the wind failed us and we drifted off with the current. A fresh afternoon breeze coming up from the southeast, enabled us to make some headway, and at 3:00 P. M. we weathered the East Crossman, arriving at Vilamil at 7:00 P. M., too late to anchor back of the reef, so let go the anchor outside in nine fathoms of water.

August 20: All hands up for early breakfast and at 7:00 o'clock we weighed anchor and made up to the anchorage, letting go anchor at 7:45 in three and one-half fathoms of water. Beck went ashore with landing party to arrange for getting some mules to make a pack train trip to the interior. After lunch, went out in the skiff with Nelson to take soundings, intending to move the schooner further in so as to get smooth water for cleaning sides and painting the waterline. Having found good, clear bottom with 14 feet of water at dead low tide, we hauled in a little further and dropped anchor. All those remaining on board the schooner turned to with brooms and scrapers, cleaning off the waterline and counter. Parker left the schooner this afternoon to stay ashore temporarily. Don Antonio is getting the pack animals mustered to take our trip to the interior. We intend to visit the northern slopes of the mountain in search of some of the larger tortoises.

August 21: All hands turned out for early breakfast, the party for the interior going ashore with equipment ready to start up the mountain. Don Antonio informed us that the mules had not arrived as yet, so we waited about the settlement to see what the prospects of getting started were. Nelson and Gifford cleaned off the waterline on the starboard side of the schooner. As no mules came down from Santo Tomas, all hands and Herr Brugeremann, the German bookkeeper, went on board the schooner for supper. Cloudy and misty most of the day.

August 22: The pack animals arrived last night and all hands, except White, Gifford and Nelson, went ashore imme-

1906

diately after breakfast and attended to getting equipment packed on the mules. We used our blankets to put over the home-made riding saddles, but even with a double thickness of blankets, we found out afterwards that walking was a pleasure. A rawhide rope took the place of a bridle. We got off about 8:00 o'clock, Beck following shortly afterwards with the Indian in charge of the pack animals. The ascent was very gradual as we passed over the barren lava fields of the lowlands. About seven miles from the coast the green zone commenced and we entered a belt of fine, green trees covered with a heavy growth of lichens. Higher up, the trail opened up onto a good earth road, the forest became denser and a heavy fog shut down on us. We passed through some clearings where timber had been cut for making fences and buildings and through several small fields of sugar cane. As we neared Santa Tomas, the forest thinned out and we came onto open grass land and within sight of the settlement, which is just above the last of the trees. Santo Tomas consists of a few thatched huts and a couple of corrugated iron buildings. We were met by Señor Puga, the head man of the village, and escorted to the larger of the buildings, which was to be our headquarters while we worked about the mountain. We were then invited to a meal at Señor Puga's house and arrived there just in time to see his wife chasing a pig from under the dining table. After a repast of beef, tortillas, syrup and rice, we returned to our headquarters to meet the pack train and get the animals unloaded. Nelson aboard the schooner cleaning and painting, while Gifford is working about the lowlands.

August 23: All hands turned out for early breakfast at Señor Puga's house. Coffee, chocolate, beef, rice, tortillas and syrup were served. After our repast, Beck, King and I got the pack train loaded and, with two Indians, started off for the top of the mountain, the rest of the party working about Santo Tomas. The natives have gathered quite a few tortoises for us and are packing them down to the coast by degrees. The pig pen adjoining our house has a number in it now awaiting transportation. As we left the settlement on our way up the mountain, we passed through a great grassy area which runs clear to the rim of the crater, 3,150 feet above sea

1906

level. We saw many medium-sized tortoises along the trail, but left them there, as we were after some of the larger ones. Hundreds of skeletons were scattered about, mostly due to the work of the oil hunters, the wild dogs being responsible for some. These can be readily distinguished by the carapace and plastron being intact. The natives cut the shell open with an ax, leaving it in small pieces. About noon we reached the top of the mountain in beautifully clear weather and had a magnificent view of the crater, some six or eight miles in diameter. The bottom has some small, brushy areas in it, but is mostly rough, black lava. A sulphur deposit at the northwest part of the rim is the only sign of activity, a small column of steam being visible. Passing over to the northwest side of the mountain, we descended onto a flat at its base and pitched camp on the site of an old one used by the oil hunters. We killed an ordinary-sized tortoise near our camp and cut out the liver for supper. Many wild cattle and dogs about our camp, the latter coming very close to our tent and showing no signs of fear. On going back to skin out the tortoise we had removed the liver from, we found that one of our guides had cut a leg off of it for his supper, so we saved the skull only. While cooking supper this evening, we saw a pack of about 20 dogs bring down a big bull. The dogs surrounded the animal, running about in a circle as they closed in on him, and, when close enough up, some of the pack bit at his heels, while others went for his nose. Finally winding the bull, one or two of the dogs made a leap for his throat, when the bull went down, with them all piling on top of him. We heard dogs barking about our camp all through the night and found that they had picked the bones of the tortoise we had killed, and even eaten some of the shell.

August 24: Turned out early this morning and started off on a tortoise hunt, our guides taking us about a large flat where the oil hunters had killed off many large ones. We found several moderate-sized ones, but none of the real big fellows we were anxious to get. King and I skinned tortoises most of the day, while Beck and the guides searched for more. The rest of the party still working about Santo Tomas.

1906

August 25: Still in camp skinning tortoises, while Beck and the guides are exploring the surrounding country. We now have about eight moderate-sized tortoises ready to pack out. Beck returned to camp this evening with the information that they were unable to find any very large tortoises and so had decided to break camp and return to Santo Tomas.

August 26: Turned out early and, after a breakfast of tortoise liver, hardtack and coffee, the guides packed the eight tortoises and camp equipment on the mules and we headed for Santo Tomas. About half way to the hacienda, King found a fairly large-sized tortoise, about as large as any we had found on the mountain, so we pushed on to the hacienda, planning on coming back on the morrow to skin it. We reached Santo Tomas late in the afternoon and found that the rest of the party had left for the coast.

August 27: Started out early this morning with the two guides to skin and pack out the tortoise King discovered yesterday. We had it skinned out shortly after noon and one of the Indians lashed it on the pack mule, when we made tracks for Santo Tomas, reaching it about 6:30 and finding that Beck had left for the coast. Ochsner, Stewart, Hunter, Gifford and Williams have just arrived from below.

August 28: With one of the Indians for a guide, we all started up for the summit to have a last look at the crater. Nobody but the botanist found much in the way of specimens. We saw a few small tortoises, but did not take them. Wild cattle seem to be all about the grassy areas and the bark of the wild dogs is frequently heard as they gather in packs to hunt them. We returned to the hacienda for supper and all hands turned in early.

August 29: Most of the party collecting about the hacienda. King and Ochsner returned to the rim of the crater to examine some ditches they had discovered yesterday. There was so much fog covering the mountain top that they could not locate the spot, so returned to the hacienda. This evening a few cockfights were held for our amusement. Don Antonio, Herr Brugermann and all our party occupy the same room in our corrugated iron mansion. The former has a bed, Herr

1906

Brugermann a hammock, and the rest of us occupy the floor. Plenty of rats running about the rafters in the night. No matter where we camp ashore, we have a plentiful supply of them.

August 30: Broke camp this morning and all hands, except Hunter and Williams, rode down to the coast. We arrived early in the afternoon and found all well on board the schooner.

August 31: King and I spent the day skinning tortoises brought down by the natives. Rest of the party on board giving Nelson a hand to shift stores over to starboard in order to paint the waterline. Nelson about finished painting the port side today. Fine weather with S.S.E. winds.

September 1: King and I skinned tortoises all day. Rest of party stowing stores and taking on water. Williams and Hunter returned from Santo Tomas this afternoon. The brigantine *Goleta* and the sloop *Ballandra*, both from Guayaquil, arrived today. The *Goleta* brought Don Antonio's father, who, on account of political troubles, had left Ecuador for the time being. Weather clouding up some this evening.

September 2: All hands keeping the Sabbath today. Don Antonio, his father and Herr Brugermann came on board for dinner at noon. They invited us all to a supper and a dance this evening, it being a farewell party, as we do not expect to return to Vilamil after leaving this time. All hands except the cook and myself went ashore to attend the festivities. A six or seven-course dinner was given, with chicken, whiskey and wine included. Numerous toasts were drunk, and, after dinner, the floor was cleared, violins and guitars broke out, and the ladies of the settlement appeared for the dance. Hunter and Ochsner performed a cake walk, much to the amusement of those present. The party lasted till 2:00 A. M. and all hands returned on board. Cloudy weather with occasional light showers during the day.

September 3: King and I skinned tortoises all day. Took on board some more water today and dumped overboard some we had already received a couple of days ago, it being too salty and tasting of sulphur. The natives are bringing it in

1906

on burros, but have to be watched closely, as they are inclined to get it from a waterhole close to the beach where it is salty and dirty instead of getting it further inland where they get the water for the settlement. Cloudy weather with occasional light showers.

September 4: Today we took on board 35 live tortoises, several sacks of atoyas and some more water. Some of the party ashore doing their last collecting at Vilamil, as we expect to sail tomorrow. Cloudy weather, but no rain.

September 5: Took on more water and provisions today. A total of 1,600 gallons of water taken on for the homeward voyage. Parker, our former navigator, was offered his passage back to San Francisco, but refused all aid and removed his effects from the vessel. By 3:00 P. M. we were ready for sea, and, bidding farewell to Don Antonio and all our friends ashore, we weighed anchor and stood out of the harbor on the port tack, dipping our colors as we passed out from behind the reef and shaped our course for Chatham Island. At 5.30 we tacked ship and at 9:00 P. M. passed about one mile to the leeward of Brattle Island. Light southerly winds with partly cloudy weather.

September 6: Opened with light southerly winds and partly cloudy sky. The schooner stood on the starboard tack throughout the night, making E.S.E. The wind freshened early in the morning and at 7:00 A. M. the northwest point of Charles Island bore by compass S.S.W., distant nine miles. Took several cross bearings during the day and found the schooner making good her course. At 7:00 P. M. we picked up the Chatham light bearing E.N.E. Course was then set N.E. until the light bore S.E. and we picked up Dalrymple Rock and tacked ship. We stood into Wreck Bay and at 9:30 P. M. we let go anchor in six fathoms about 600 yards off the wharf. Made sails fast and all hands turned in.

September 7. All hands turned out early. Hunter, Beck, Ochsner and Williams went up to the hacienda for mail. They brought back plenty of papers, but only four letters. Landing party ashore doing general collecting. Nelson and I rigged up preventers on the jibstay, forestay and bobstay, the same

1906

being partly rotten. All hands on board for supper, Williams returning on shore to do some night collecting. Partly cloudy with moderate southerly breeze.

September 8: Stewart and Williams emptied out a tank of Albemarle water, Beck having decided to take on some here, as it is excellent drinking water. We took on some small stores and a keg of beef, sent by the American Consul at Guayaquil. King and I skinned tortoises all day. Nelson fumigated the cabin this evening and all hands slept on deck. Cloudy weather with fresh southerly winds.

September 9: Opened up the cabin at 7:00 A. M. and found that the sulphur had done its work well, killing numberless flies, bedbugs and cockroaches. As soon as the cabin was aired out sufficiently, the cook prepared breakfast. Many visitors aboard today looking over the schooner and our specimens. Fresh southerly breeze and somewhat misty this afternoon. We found our chronometer to be 39' 44" slow on G. M. T. at 4:00 P. M.

September 10: Took on board 400 gallons of water, hauled down by ox team from the hacienda. Beck had the vessel cleared for the return journey to San Francisco. The Governor requested Beck to take him and a party of three to Vilamil to interview Señor Gil Sr. It appears that he was exiled from Ecuador and was ordered to report to the Governor at Chatham before going to Vilamil. This he failed to do and the Governor wanted to go over and see why. At 4:00 o'clock he arrived on board the schooner with a West Indian negro as interpreter, his secretary, and a soldier with a gun of the vintage of 1870. Some baggage and a saddle came on board later. At 4:30 we set sails and weighed anchor. Clearing the reef at the entrance of the bay, we set course SW. by W. with fresh southerly breeze. The soldier proceeded to get sick at once, but His Excellency the Governor was not effected in any way and at dinner time he stowed away enough food for a regiment. At midnight, Barrington Island bore by compass NE., distant eight miles.

September 11: Opened with light winds and hazy weather, clearing about nine o'clock. At noon we hove to off the boat

1906

entrance through the reef opposite Vilamil; and Beck, Ochsner and King took the Governor and party ashore. As our guests had made such inroads on a box of oranges we had, forgetting that they had a sack full of their own, we "forgot" to put it into the boat with the rest of the baggage. While awaiting the return of the boat, we beat to windward of the reef, keeping a sharp lookout for it. At 4:00 o'clock the boat was sighted coming through the reef, so we ran down before the wind and picked it up. Our course was then shaped for Tower Island, taking our departure from a rock to the northward of Brattle Island with the intention of passing to the southward of Indefatigable. Had a fair breeze up to 11:00 P. M., when it fell calm with misty weather. At midnight the Crossman Islands bore by compass NW. by W., distant eight miles.

September 12: Opened with light airs and hazy weather. Schooner heading E. The wind freshened towards noon and weather cleared somewhat. Great numbers of phalaropes seen swimming about and many shearwaters and albatrosses circling about the schooner. At 6:00 P. M. Barrington Island bore by compass E. by N., distant eight miles. The fog shut down on us at 9:00 o'clock and made navigating rather dangerous.

September 13: Weather foggy. At 12:30 A. M. Barrington Island loomed through the haze dead ahead, the current setting us to the southward instead of to the northward as indicated on the chart. According to our reckoning, when I relieved Nelson at midnight we should have been past Barrington. On seeing it get so black ahead, I ran forward to take a look around and thought I could hear the sound of the surf. Shouting to Ochsner to throw the helm hard up, I ran aft to slack off the main sheet and put the schooner before the wind. Nelson was called, and, just as he reached the deck, the fog thinned somewhat and we could see Barrington Island close on our starboard beam. At 3:00 A. M. set course NE. by E. and at 4:00 A. M. the east end of Barrington bore by compass S.SE., distant four miles. At 8:00 o'clock set course for Tower Island and winged out the foresail. Schooner going before a stiff breeze and making fine time.

1906

Tower Island was sighted at 3:00 P. M. and at 5:00 P. M. the schooner was put on the starboard tack, as we were not able to make the anchorage by daylight. At 6:00 P. M. the island bore by compass NW. by N. $\frac{1}{4}$ N., distant 14 miles. Hauled down the flying-jib and made it fast. Strong southerly winds throughout the night and the schooner was kept close hauled, making a course E.S.E. magnetic.

September 14: Opened with fresh southerly winds and heavy sea. Tacked ship at 1:00 A. M. At 6:00 A. M. shaped course for Tower Island, sighting it at 8:30 bearing N.N.W. We made up to the south coast, passing by Darwin Bay ("discovered by Beebe"),⁶ as we had no desire to anchor on the weather side of the island, having had enough experience in getting away from some of our other anchorages, when trying to beat against the wind. Sailing around to the northeast side, we lowered the ship's boat and went in to take soundings and buoy an anchorage. Finding bottom at ten fathoms, the spot was buoyed and at 12:15 we let go anchor. All hands, except King and myself, ashore for general collecting, returning at 5:30 P. M. Weather partly cloudy with light southerly breeze at sundown.

September 15: All hands ashore immediately after breakfast. Beck went over to the south side of the island and killed a fur seal, bringing back the skull and skin. Ochsner and I made a trip inland to the crater lake ("discovered by Dwight Franklin")⁷ and found Stewart collecting about the rim of it. After making a search for lizards and snakes and finding none, I left Ochsner and Stewart to explore the lake and returned to the coast to help King collect some sea iguanas, the only reptiles found on the island. Plenty of fine fish along the shores and Nelson caught several big barcalau. Light S.S.E. winds and cloudy sky throughout the day.

September 16: Sunday morning and late breakfast. At 10:00 A. M. we set sails and weighed anchor, shaping our course for Bindloe Island. We made up to the island at 4:00 P. M. and lowered the boat to sound for an anchorage. Finding

⁶ Galapagos: World's End, p. 311. Beck spent some time in this bay on board the schooner *Mary Sachs* in 1902.

⁷ The Arcturus Adventure, fig. 67.

1906

none on the east side, we circled around to the northward and let go anchor off the north side in $7\frac{1}{2}$ fathoms of water with rocky bottom. Abingdon Island bears by compass NW. $\frac{1}{2}$ W.

September 17: Shore party landed immediately after breakfast, pulling down the coast about a mile and a half from the anchorage where some soil reached down to the water's edge. Collected with Williams most of the day and secured quite a lot of lizards. Beck went to the summit of the island and found a few small steam holes in action. Bindloe and Tower islands are quite uninteresting compared to some of the southern ones. Cowley, Tagus Cove, Banks Bay Mountain and the top of James Island in sight from our anchorage. Fine, clear evening with light southerly winds.

September 18: Beck, Stewart and Williams went ashore to collect about the anchorage and returned at 9:00 o'clock. Set sails and weighed anchor, shaping our course for Abingdon Island, plainly visible from the anchorage. At 12:40 P. M. we made up to the south coast of the island and let go anchor in seven fathoms of water, Cape Ibbetson bearing E. $\frac{1}{2}$ S., distant about 800 yards. Landing party went ashore at once. We found fairly open country and good walking about the lower levels. Above, we could see a brown and a green zone, reminding us of Indefatigable, only on a smaller scale. Cloudy weather with light southerly winds. We had to anchor on the weather side of the island, so have plenty of chain out. However, the wind and sea are both light and the schooner is riding easily.

September 19: All hands turned out early so some of the landing party could get started for the top of the island. Ochsner, King, Williams and I started up for the green zone on a tortoise hunt. We just got to the edge of the green belt when we discovered fresh signs and, following up the trail, came upon a tortoise drinking water from a hole in the top of a large, flat rock. King and I stopped and skinned out this tortoise, while Ochsner and Williams continued up the mountain, locating another tortoise just above us. They reached fairly near the top, finding a heavy growth of tree ferns, but no large trees. As visibility was poor on account of the fog, they had no view. On the northeast side of the summit, at

1906

the base of two small cones, vapour was seen rising from a hole in the lava and the ground about it was quite warm. Eating their lunch at this point, they came back down the trail and helped King and me pack out the tortoise we had skinned. We met Beck at the beach and he informed us he had found another tortoise just below the spot we had skinned out ours. Hunter camped near the green zone for the night to hunt owls and bats. Williams and I went ashore after supper to collect with his lantern till about 8:00 o'clock. Cloudy weather during the day with very light southerly winds.

September 20: Ashore with King to skin and pack out the tortoise Ochsner and Williams found yesterday. Beck went back to the green zone to look for a tortoise he found the trail of yesterday. King and I had our tortoise skinned and down to the beach at 6:00 P. M. Nelson overhauled some of the rigging and set up the bobstay. Cloudy weather with light southerly winds.

September 21: King and I went up the mountain to skin and pack out another tortoise found by Beck. We located it on the southern slope of the mountain a mile or so from the edge of the green zone. Beck found one more tortoise today, but said it was too far away to pack out, so left it. He brought out one skeleton which he found in a cave. King and I got our tortoise down to the beach at 5:30. Cloudy weather with light rains in the morning.

September 22: All hands ashore after breakfast. King and I gathered a lot of cactus for the live tortoises on board. The deck is crowded with them and we are skinning them as fast as possible. Foggy and rainy about the summit of the island today. Williams caught a good-sized barcalau while coming in with the boat to pick up the landing party. All hands on board for 6:00 o'clock supper.

September 23: Breakfast at 7:00 o'clock. Beck went ashore to take some photographs and King and I went after more cactus for the tortoises. During the morning we had light southerly winds, which freshened towards 10:00 o'clock, and at 11:00 o'clock we hoisted sails and weighed anchor. Made short tacks to the eastward till we cleared the shore.

1906

The schooner was now put on the port tack and course set to the westward, towards Cape Chalmers, which we passed at 1:00 P. M., shaping our course for Wenman Island. Cleared up decks as much as possible to make ready for sea. Unbent anchor chains and secured anchors. Fresh southerly breeze and the schooner is logging about eight knots. At 11:00 P. M. sighted Wenman Island bearing NW., distant about six miles. Hauled the schooner on the wind so as to beat to windward of the island during the night.

September 24: At 7:00 A. M. ran down before the wind and at 9:00 A. M. hove to under the lee of Wenman Island. All hands, except White and Nelson, landed on the north slope in a small, sheltered cove. The island is a huge flat-topped rock covered with a dense growth of low-growing *Opuntia*. The cactus made traveling somewhat difficult and most of our efforts were confined to collecting about the edges of the plateau, where there are a few clear spaces. Despite the fact that Wenman is merely an isolated rock, we found the little Galapagos dove quite plentiful, as well as some of the smaller land birds. The landing party was called off at 1:00 P. M. Quite a sea was running about the north point of the island and when we got clear from the shelter of the landing place we shipped green water into the boat. During the afternoon we kept the schooner hove to on the port tack so as to run down to Culpepper Island in the morning. King and I skinned tortoises for the rest of the day.

September 25: At 3:00 A. M. shaped course for Culpepper Island, heaving to under the lee of it at 10:00 A. M. We found Culpepper a most uninviting spot, being merely a flat-topped rock, considerably smaller than Wenman. There were numberless seabirds flying over the top of it. Put off in the skiff with Beck, Ochsner, Hunter and Williams to make a landing. This proved somewhat difficult owing to a choppy sea and the huge boulders which bordered a ledge we had to land on. We succeeded in making a landing at the base of a cliff which towered some 500 feet above us. A few sea iguanas seemed to be the only inhabitants about this spot, the birds all being about the top of the rock. Several large sharks were seen close to the precipitous cliff near the ledge

1906

we landed on. Finding the summit quite inaccessible, we gathered a few sea iguanas and shoved off for the schooner. This was our last landing on the Enchanted Isles. At 1:45 P. M. we shaped our course for Clarion Island, taking departure from Culpepper bearing SE. magnetic, distant about one-half a mile. With a fresh S.S.E. wind, we streamed the log, winged out the foresail and ran before the wind, bidding good-bye to the Galapagos on the first day of the passage back to San Francisco and the 455th day of the voyage. Weather cloudy with some fog and rain squalls towards evening.

September 26: Opened with strong breeze from S.S.W. At 10:00 A. M. we hauled in the foresail owing to the shift of wind. Heavy southerly swell running and the schooner is logging nine knots. King and I, with some assistance, busy skinning tortoises in order to clear up the decks before getting too far north. Lat. $5^{\circ} 34' N.$, Long. $95^{\circ} 27' W.$ at meridian.

September 27: Opened with fresh S.S.W. winds and light rain squalls during the forenoon. Last night we had a shift of wind to the westward, accompanied by heavy rains. At 7:00 A. M. it hauled back to the SW. Heavy southerly swell continues. During the midwatch the main lift strop carried away and was replaced this morning. Still busy skinning tortoises. The temperature and water are getting much warmer now and numbers of shearwaters are circling about the schooner. Lat. $7^{\circ} 24' N.$, Long. $97^{\circ} 48' W.$ at meridian.

September 28: Opened with strong breeze from the SW accompanied by heavy rain squalls. Heavy southerly swell continues with occasional cross swell from the NW. We are rapidly approaching the doldrums. At 5:00 o'clock this morning the forestaysail halyards and the gaff-topsail tack carried away. Same were repaired and sails set again by 6:30. Our noon observation showed a strong current setting us to the eastward. Tortoise skinning going on as usual and we are making some inroads on them. Lat. $9^{\circ} 22' N.$, Long. $98^{\circ} 25' W.$ by dead reckoning at meridian.

September 29: Opened with strong southerly winds and heavy rain squalls. Schooner pitching heavily and shipping some green water. A school of grampus passed close by our

1906

weather side and many flyingfish about. The heavy squalls continuing at 4:00 o'clock, we took in the flying-jib and gaff-topsail. Tortoise skinning discontinued today on account of bad weather. Lat. $9^{\circ} 59' N.$, Long. $100^{\circ} 25' W.$ at meridian.

September 30: Opened with strong wind and heavy seas and squalls from the S.S.W. At 1:00 P. M. took one reef in the fore and mainsails. Schooner logging nine knots at times. Sighted several turtles during the day. Sea quite choppy and no work done on the tortoises. Lat. $11^{\circ} 05' 30'' N.$, Long. $102^{\circ} 09' W.$ at meridian.

October 1. Wind moderated during the night and at 7:00 A. M. shook the reef out of the foresail. Heavy swell from the S.S.W. still continues. Sky overcast, but no rain. Started skinning tortoises again. Nelson rove new main throat-halyards this morning. Our long cruise and wear on the running rigging during the calms we went through amongst the islands, is beginning to be felt when we make any heavy weather. Lat. $12^{\circ} 19' N.$, Long. $104^{\circ} 03' W.$ at meridian.

October 2: Opened with strong winds and heavy sea from the S.S.W., the wind hauling to the SW during the morning. Took in the flying-jib at 6:00 A. M. and the foresail at 9:00. Took one reef in the mainsail and carried it the rest of the day with the forestaysail. Main lift strop carried away during the midwatch and was replaced this morning. Lat. $14^{\circ} 24' N.$, Long. $106^{\circ} 42' W.$ at meridian.

October 3. Opened with heavy winds and squalls. At 5:00 P. M. put a double reef in the foresail and set same. Sea appears to be increasing and wind not quite so steady. Early this morning the schooner listed heavily to leeward, spilling a jug of molasses and a crate of onions over the cabin floor, together with some of Stewart's plants and what mess gear there was on the table. Lots of dishes broke. No attempt made to skin tortoises today, but all hands turned to and cleaned up the mess in the cabin. Pumped out considerable bilge water this evening. Lat. $14^{\circ} 24' N.$, Long. $107^{\circ} 05' W.$ at meridian.

October 4: Wind and sea went down during the night and this morning opened with light winds and calms. At 6:00

1906

A. M. shook out the reefs in the fore and mainsails. At 12:30 P. M. the leech on the mainsail carried away and the sail was lowered for repairs. Lowered head sails also and let the schooner go with the foresail alone. Fine afternoon, but rather sultry. Beck and Gifford went out in the skiff shooting birds. King working on tortoises, while I am helping Nelson repair the mainsail. Lat. $14^{\circ} 48' N.$, Long. $107^{\circ} 02' W.$ at meridian.

October 5: Opened with light winds and calms. At 10:00 o'clock repairs on the mainsail were finished and all sails were set. The wind having hauled to the NW., we tacked ship and headed W. by N. on the starboard tack. Beck out in the boat again shooting birds. King and I still on the tortoises, when not taking a turn at the wheel or taking the deck. Lat. $14^{\circ} 45' N.$, Long. $108^{\circ} 30' W.$ at meridian.

October 6: Opened with light winds from the N.NW., falling to dead calm at 6:00 P. M. Lowered the foresail for repairs and set same at 10:00 P. M. All hands skinning tortoises when not otherwise occupied. Rather warm today and some of us sleeping on deck. Lat. $14^{\circ} 38' N.$, Long. $109^{\circ} 12' W.$ at meridian.

October 7: Opened with light breeze from the NW., calming down towards evening. Moderate swell from the S. with small counter swell from the N.NE. Only a few birds seen about today. Lat. $14^{\circ} 40' N.$, Long. $109^{\circ} 26' W.$ at meridian.

October 8: Opened with light airs and calms, the schooner, at times, not having steerage-way. Considerable swell from the NW. Beck went out shooting birds this morning. Everybody, when not otherwise engaged, busy skinning tortoises. Lat. $14^{\circ} 11' N.$, Long. $109^{\circ} 38' W.$ at meridian.

October 9: No change in weather. We are taking advantage of the opportunity to get the decks cleared of tortoises and all hands keep busy with the skinning knives. The current set us back about five miles to the southward during the last 24 hours. Lat. $14^{\circ} 26' N.$, Long. $109^{\circ} 26' W.$ at meridian.

October 10: Opened with light winds and clear weather, the schooner having some steerage-way. Considerable swell

1906

from the NW. continues. Beck out in the boat shooting birds, while the rest of the party, who can be spared, are skinning tortoises. Nelson rigged a preventer on the forestay, the chain plates having pulled out. Williams sighted a couple of bonitas under the bow, but met with no success at fishing. Lat. $14^{\circ} 36' 30''$ N., Long. $109^{\circ} 42'$ W. at meridian.

October 11: Opened with light unsteady winds and fine weather, a couple of light rain squalls passing over us during the morning watch. While Williams was fishing off the flying-jib boom, a booby lit on the spar within a couple of feet of him and was promptly grabbed by the neck and turned over to the ornithologists. Light winds most of the day, the schooner making about W. by N. Lat. $15^{\circ} 16'$ N., Long. $110^{\circ} 01'$ W. at meridian.

October 12: Opened with light airs and calms and moderate NW. swell. Skinning tortoises as fast as possible while the fine weather holds out. Six were skinned today. Some of us taking advantage of the spells of dead calm to go over the side for a swim. Water fine and warm. Lat. $15^{\circ} 36'$ N., Long. $110^{\circ} 12'$ W. at meridian.

October 13: Opened with light airs and calms, the breeze freshening towards nightfall. Beck out in the boat this morning shooting birds. The last tortoise was skinned this morning. As soon as they soak for a couple of days we shall be able to knock down the pickle tubs and stow them away so we can have a clear deck. Lat. $15^{\circ} 31'$ N., Long. $110^{\circ} 43'$ W. at meridian.

October 14: Opened with fair breeze and moderate sea. Schooner logging about four knots. Today, being Sunday, nothing but the running of the vessel attended to. We are not able to catch any fish at present and our diet of canned salmon and beans is getting a little irksome to some of the party. Boobies, shearwaters and tropic-birds observed today. Lat. $15^{\circ} 54'$ N., Long. $112^{\circ} 08'$ W. at meridian.

October 15: Opened with fresh breeze and moderate swell. Schooner making about NW. and logging five to six knots. According to our observations, a strong westerly current is running. King and Hunter knocked down the pickle tubs and

1906

stowed them below. We now have a clear deck for running into the heavy NW. winds we might expect off the California coast at this time of year. Lat. $16^{\circ} 25' N.$, Long. $113^{\circ} 40' W.$ at meridian.

October 16: Opened with fresh breeze, which grew lighter towards evening. Moderate swell from the NW. At 5:00 P. M. we put the schooner on the port tack, making about NE. by E. Our principal activities these days are running the schooner and shooting birds during periods of calms and light breezes. Lat. $16^{\circ} 45' N.$, Long. $113^{\circ} 09' W.$ at meridian.

October 17: Opened with light northerly winds and smooth sea. At midnight tacked ship again and are now heading about W.NW., logging from two to four knots. Boobies, frigate-birds and flyingfish quite numerous about the schooner. Lat. $16^{\circ} 55' N.$, Long. $112^{\circ} 55' W.$ at meridian.

October 18: Opened with light breeze and fine, clear weather. Some of us sleeping on deck at nights. Nelson and I greased down the masts today. Mosquitoes, hatching out from the tank of water we got at Chatham Island, getting somewhat troublesome. We are still unable to catch any fish and are going strong on the canned salmon and beans. Lat. $17^{\circ} 10' 30'' N.$, Long. $113^{\circ} 27' W.$ at meridian.

October 19: Opened with light unsteady winds and calms. Small swell from the NW. At 4:00 A. M. the wind fell to nearly calm and the schooner was put on the port tack until 8:00 A. M., when the wind hauled back to the northward. Williams finally caught a bonita this afternoon, so we will ease off on the salmon for supper. Weather quite warm today. Lat. $17^{\circ} 20' 30'' N.$, Long. $114^{\circ} 06' W.$ at meridian.

October 20: Opened with very light winds and fair weather. Swell from the NW. still continues. A few bonitas about the schooner today, but we failed to catch any. Clarion Island is not far off now, but as yet we have been unable to sight it. Nelson and I rove off a new mainsheet this afternoon. Schooner making about NW. and logging four knots. Lat. $17^{\circ} 44' N.$, Long. $114^{\circ} 58' W.$ at meridian.

October 21: Opened with light unsteady winds and cloudy weather. Tacked ship at 8:00 A. M. At 9:30 we sighted

1906

Clarion Island from the crosstrees, bearing by compass N. by E., distant about 25 miles. At noon it bore N. $\frac{1}{2}$ W. magnetic. The wind increased towards noon and a heavy swell set in. Beck decided not to try and make Clarion, the object in sighting it being to get a check on our chronometer. The schooner was now put on the starboard tack and, passing to the southwestward of Clarion, the course was set for San Francisco Lat. $17^{\circ} 53' N.$, Long. $114^{\circ} 45' 30'' W.$ at meridian.

October 22: Opened with fresh breeze and cloudy sky. We did not get a very good check on our chronometer, owing to hazy weather and uncertain latitude. Clarion was lost to view at 2:00 P. M. This morning we set up the port fore rigging and broke up the tortoise pen we had rigged abaft the foremast. This evening we sighted great numbers of boobies heading in the direction of Clarion. Lat. $18^{\circ} 16' N.$, Long. $115^{\circ} 46' W.$ at meridian.

October 23: Opened with light airs and calms, a fresh breeze setting in later in the morning. A heavy rain shower, lasting about ten minutes, passed over us as the breeze freshened up. Considerable swell from the NW. Set up the port main rigging this morning. One of the tortoises we have kept to bring back to San Francisco alive fell overboard and we had to put back to pick it up. Williams and I put off in the ship's boat to the rescue, but it leaked so badly we had to bail vigorously and make for the schooner. We took the boat in on deck for calking and sailed after the tortoise, picking it up with a boat hook. Current set us 16 miles SW. by W. true during the last 24 hours. Lat. $19^{\circ} N.$, Long. $116^{\circ} 41' W.$ at meridian.

October 24: Opened with fresh breeze and cloudy weather, the wind getting lighter towards evening and the swell going down considerably. Many flyingfish about today. Schooner making about NW. and logging two to four knots. Ship's boat being overhauled, calked and painted. Lat. $19^{\circ} 53' N.$, Long. $118^{\circ} 01' W.$ at meridian.

October 25: Opened with light winds and smooth sea. All hands busy scrubbing paintwork and getting ready to do some

1906

painting about decks. Williams caught some bonitas this morning, much to the delight of Hunter, who has grown to hate the sight of a can of salmon, not to say anything of its contents. Lat. $20^{\circ} 20' N.$, Long. $118^{\circ} 44' W.$ at meridian.

October 26: Opened with fine, clear weather and smooth sea. Taking advantage of the fine weather to paint about decks. No fish sighted today and only one or two petrels seen. Schooner making about NW. by W. and logging two to three knots. Lat. $20^{\circ} 37' N.$, Long. $119^{\circ} 17' W.$ at meridian.

October 27: Opened with fair breeze and clear weather. All hands busy painting. This evening we thought we sighted a sail to the westward, but could not make it out well enough to be certain. Lat. $21^{\circ} 45' N.$, Long. $120^{\circ} 32' 30'' W.$ at meridian.

October 28: Today, being Sunday, no work outside of standing watches being done. Fair breeze and smooth sea with sky somewhat overcast. Schooner making about N.NW. and logging from four to five knots. Lat. $23^{\circ} 02' 30'' N.$, Long. $121^{\circ} 45' W.$ at meridian.

October 29: Opened with fine sailing breeze. Weather slightly cloudy with smooth sea. All hands busy painting and chipping iron rust. Few birds seen today. Lat. $24^{\circ} 31' 30'' N.$, Long. $122^{\circ} 52' W.$ at meridian.

October 30: Opened with fresh breeze and cloudy weather. Swell from the northward increasing. We are north of the Tropic of Cancer now and the weather is considerably cooler. At 6:00 o'clock this evening we passed a three-masted, full-rigged ship bound southward. Lat. $25^{\circ} 25' N.$, Long. $124^{\circ} 20' W.$ by dead reckoning at meridian.

October 31: Opened with fresh breeze and cloudy weather. A couple of light rain showers passed over us this morning. Heavy swell from the northward and all hands are commencing to feel the cold. We have about finished painting and have turned to oiling down the decks. This evening the wind is stronger and it looks as if we may be running into some bad weather. A piece of driftwood passed us this afternoon. Lat. $26^{\circ} 24' N.$, Long. $126^{\circ} 23' W.$ at meridian.

1906

November 1: Wind died down during the night, but cloudy weather and heavy N.N.W. swell continue. At 10:00 o'clock last night the topsail sheet carried away and the topsail was made fast for the night. At 11:00 A. M. lowered the main-sail and rove off a new topsail sheet. Set all sails again just before noon. Several Black-footed Albatrosses sighted today. Everybody feeling cold and breaking out underwear to put on. At 8:00 P. M. a sail was sighted to windward of us; hull down. Lat. $26^{\circ} 50' N.$, Long. $126^{\circ} 50' W.$ at meridian.

November 2: Opened with dead calm. Two Black-footed Albatrosses sighted this morning and one of them was hooked by King while trolling a fish line astern. Finished oiling down the decks this morning. Weather cool and sweaters and overcoats are in vogue. Wonderful moon rise this evening and water full of phosphorescent jelly-fish. Lat. $26^{\circ} 51' N.$, Long. $126^{\circ} 49' W.$ at meridian.

November 3: Opened with dead calm and long NW. swell. Took advantage of the weather to lower and repair the main-sail. Also rove off new forepeak halyards and repaired the staysail. A big shark sighted this morning. Gifford shot an albatross this afternoon and we lowered the ship's boat to pick it up. This time the boat floated and did not require the services of a bailer. Calm moonlight night. Lat. $26^{\circ} 50' N.$, Long. $126^{\circ} 47' 30'' W.$ at meridian.

November 4: Opened with dead calm and heavy NW. swell running. At 8:00 A. M. a SE. breeze sprang up, hauling around to all points of the compass and finally settling in the N.N.E. Sighted a sail to windward, but lost it again when a heavy rain storm passed over us. Took in the flying-jib for repairs. Williams hooked a fine, large dolphin from the flying-jib boom. Lat. $26^{\circ} 58' N.$, Long. $126^{\circ} 54' W.$ at meridian.

November 5: Opened calm. At 8:00 A. M. a squall passed over us, bringing with it a NE. wind. Heavy NW. swell running and the schooner is heading up well. Nelson and I busy repairing the flying-jib. Lat. $28^{\circ} 20' N.$, Long. $127^{\circ} 58' W.$ at meridian.

November 6: Opened with fresh breeze and partly cloudy weather, the wind getting lighter towards noon and the swell

1906

going down. At 6:00 A. M. a sail was sighted off the lee bow; hull down. Nelson and I still working on the flying-jib. Lat. $29^{\circ} 38' N.$, Long. $129^{\circ} 02' W.$ at meridian.

November 7: Opened with light unsteady winds and cloudy weather. Some tropic-birds and Black-footed Albatrosses sighted this morning, one of the latter being hooked with a fish line trailing astern. Nelson and I bent the flying-jib this morning. Lat. $30^{\circ} 23' N.$, Long. $130^{\circ} 13' W.$ at meridian.

November 8: Opened with light unsteady winds and cloudy sky. At 6:00 P. M. a large barque-rigged vessel passed across our bow standing NE. The breeze calmed down during the night and left us both becalmed within sight of each other. Lat. $30^{\circ} 33' N.$, Long. $130^{\circ} 58' W.$ at meridian.

November 9: 500 days out from San Francisco today!!! Opened calm. Daybreak found us within half a mile or so of the barque sighted last night and, at eight bells, we showed our colors and sent a boat aboard. Nelson wishing to get a check on our chronometer. She proved to be the French barque *L'Hermite* 125 days out from Dunkerque, France, bound for San Francisco with a load of cement. Nelson asked her captain to report us when he got in.* At noon the *L'Hermite* was still in sight of us about four miles off. Lat. $30^{\circ} 48' N.$, Long. $131^{\circ} 09' W.$ at meridian.

November 10: Opened with light unsteady breezes, cloudy weather and some showers. Long swell from the W.NW. At 8:00 A. M. sighted another barque to the southeastward of us. At sundown the *L'Hermite* is still in sight of us to the W.NW. Keeping a sharp lookout at nights now, as we are directly in the sailing ship track. Lat. $31^{\circ} 33' N.$, Long. $131^{\circ} 44' W.$ at meridian.

November 11. Opened with light variable winds accompanied by mist and patches of fog. Sighted another square-rigged vessel to the SW. of us, making three vessels in sight this afternoon. During one of our calm spells, a fulmar lighted on the water almost under the counter and Williams

* The *L'Hermite* got in two weeks ahead of us and reported having spoken us, giving our families the first news of us in some months.

1906

caught it with a dip net. Schooner making about NW. and logging from two to three knots. Lat. $31^{\circ} 54' N.$, Long. $132^{\circ} 11' W.$ at meridian.

November 12. Opened with damp, misty weather and heavy swell from the NW. Moderate breeze blowing. No vessels in sight this morning. Very few birds and no fish about us now. Weather keeps getting colder and colder. Lat. $32^{\circ} 38' N.$, Long $133^{\circ} 30' W.$ at meridian.

November 13: Opened with misty weather and moderate breeze from the NE. Heavy swell from the NW. Sighted two square-rigged vessels this morning—a barque and a ship. Apparently both were bound for coast ports. At 10:00 A. M. lowered the mainsail for repairs. During a calm spell this afternoon Beck had the boat out and went shooting birds. Lat. $33^{\circ} 07' N.$, Long. $134^{\circ} 06' W.$ at meridian.

November 14: Opened with moderate breeze and cloudy weather. Sighted a light during the night and, when day broke, found a large three-masted ship close aboard with top-gallant, royals and skysails set. Lowered the mainsail again for repairs, setting same at 4:50 P. M. Lat. $33^{\circ} 47' N.$, Long. $133^{\circ} 21' W.$ at meridian.

November 15: Opened with moderate breeze and clear weather. Heavy swell from the NW. Tacked ship at 1:00 P. M. and again at 7:00 P. M., the schooner making about N.NE. and logging four to five knots. The cook parboiled and fried an albatross for supper this evening, some of the party wanting to get the taste of salmon out of their mouths, it being the 52nd day on a diet of salmon and beans. The bird did not prove a great success, having a dry, oily taste. Lat. $33^{\circ} 54' N.$, Long. $132^{\circ} 29' W.$ at meridian.

November 16: Opened with clear weather and unsteady winds from the N.NW. Heavy NW. swell running. A great many Black-footed Albatrosses about this morning. Schooner on port tack, making about N. by E. and logging two to four knots. Lat. $34^{\circ} 30' N.$, Long. $130^{\circ} 42' W.$ at meridian.

November 17: Opened with fine, clear weather, fresh northerly winds and choppy sea. The wind hauling to the NE., the schooner was put on the starboard tack at 1:00

1906

P. M. Nelson overhauled some of the equipment today and found that the rockets for distress signals were so damp that they would not light. The cold north winds make us put on all the clothes we own. Lat. $35^{\circ} 14' N.$, Long. $132^{\circ} 29' W.$ at meridian.

November 18: Opened with light breezes and calms. Beck went out this morning to shoot birds. A light breeze came up this afternoon and, as there were plenty of Black-footed Albatrosses about, we tried our luck at hooking them on a fish line. We caught 18 in all and the ornithologists will have plenty to do for a while. Schooner still on the starboard tack, making about NW. Lat. $35^{\circ} 40' N.$, Long. $133^{\circ} 14' W.$ at meridian.

November 19: Opened with calm weather and slightly cloudy sky. About 2:00 A. M. a light breeze sprang up from the N.NW. At 4:00 A. M. the weather became misty and the wind shifted two points to the northward. At noon the schooner was put on the port tack and made N. by E., logging three to four knots. Had a little sun to warm us up this afternoon. Lat. $36^{\circ} 03' N.$, Long. $131^{\circ} 59' W.$ at meridian.

November 20: Opened with moderate breeze from the NE. The wind freshened during the afternoon and kicked up a little sea. Sighted a whale this morning. Weather cold and overcoats and rubber boots are worn while standing watches. Lat. $36^{\circ} 49' N.$, Long. $133^{\circ} 41' W.$ at meridian.

November 21: Opened with moderate breeze from the NE. and slightly cloudy weather. Schooner making about NW. by N. and logging four to six knots. No birds about today. All hands anxious for a shift of wind so we can head in towards the coast. Owing to the changeable weather and being in the sailing ship track, we keep a full watch on deck at night. Lat. $37^{\circ} 45' N.$, Long. $134^{\circ} 50' W.$ at meridian.

November 22: Opened with fresh breeze and partly cloudy weather. Caught several more albatrosses today. The cook fried another for supper, but I am sticking to the salmon and beans. Ornithologists busy skinning the albatrosses we catch. Lat. $38^{\circ} 10' N.$, Long. $134^{\circ} 35' W.$ at meridian.

1906

November 23: Opened with fresh breeze, cloudy weather and heavy N.NE swell. At 1:45 A. M. the schooner was put on the port tack and is making about NE. 5:30 A. M. the leech of the mainsail carried away and the sail was lowered for repairs. Hauled down flying-jib and staysail to make the schooner head up. Set all sail again at 2:00 P. M. Weather turned squally towards evening and at midnight we made fast the flying-jib. Lat. $37^{\circ} 55' N.$, Long. $132^{\circ} 37' W.$ at meridian.

November 24: Opened with strong breeze from the NW. At 6:00 A. M. took in the gaff-topsail. A cross swell running, but not heavy enough to make the vessel labor. Schooner making NE. and logging about five knots. Lat. $37^{\circ} 22' N.$, Long. $130^{\circ} 46' W.$ at meridian.

November 25: Opened with heavy wind from the N.NE. and a heavy sea from the northward. At 7:00 A. M. the foresail ripped out of the bolt-ropes while we were trying to reef it. Made the sail fast till weather moderated. Schooner making heavy weather of it now and shipping green water over the bow. At 4:30 P. M. we took two reefs in the mainsail. Making about E.NE. Lat. $36^{\circ} 43' N.$, Long. $129^{\circ} 03' W.$ at meridian.

November 26: Wind and sea moderating and hauling gradually towards the NW. Nelson and I busy repairing the foresail. Sky overcast and it is trying hard to rain. No albatrosses sighted today. Lat. $36^{\circ} 22' N.$, Long. $127^{\circ} 51' W.$ at meridian.

November 27: Opened with moderate sea and NW. wind. Shook out two reefs in the mainsail and set the flying-jib. At 2:00 P. M. a big, four-masted schooner passed to windward of us. At 5:00 P. M. Nelson and I finished repairing the foresail and same was set with some difficulty, as the breeze was quite fresh. We have made considerable leeway during the past 24 hours on account of heavy seas and shortened sail. At 3:00 A. M. we were struck by a white squall from the NW., carrying away the martingale stay and flying-jib boom and tearing a hole in the mainsail. All hands were turned out to clear away the wreckage. The breeze continues fresh and

1906

the mainsail is holding out, but we are watching for a chance to lower it. The wind is moderating some as night approaches. Lat. $37^{\circ} 20' N.$, Long. $125^{\circ} 21' W.$ at meridian.

November 28: Opened with light breezes to almost calm. Took advantage of the calm spell to lower the mainsail and Nelson and I made a hasty job of patching it. At 8:30 this morning we all got a thrill when the South Farallon Light was sighted from the fore crosstrees, distant about 18 miles. At noon the island bore N., distant $1\frac{1}{2}$ miles. The wind went down and at nightfall we were becalmed.

November 29: Opened with light breeze from the north. Everybody much elated over the prospects of getting in. Razors were broke out and we all took a shave, some for the first and some for the second time in 17 months. Old clothes are being thrown overboard so the Board of Health will not hold us up, and we are washing in fresh water. At noon we set our course for the lightship and made up to it at 3:00 P. M. Here we picked up our pilot, Captain George Kortz, famous to all mariners entering the port of San Francisco, and shaped our course for the Golden Gate. The wind dropped on us again and we lay becalmed. Being Thanksgiving Day, we could not get a tug, so, instead of the turkey we all longed for, we had our daily dish of Alaska salmon. With the help of light breezes and a strong incoming tide, we drifted through the Golden Gate and narrowly missed colliding with the pilot boat *Lady Mine*, which was in the same predicament as ourselves. By 9:00 P. M. we reached Lime Point and came so close to the rocks that we put out the ship's boat and tried to pull the schooner's head around. Not succeeding in this, we hailed a passing crab fisherman, in his fishing smack *Louisa*, and, for the sum of ten dollars, he agreed to tow us across to the quarantine station, where we arrived at 10:15 P. M., 65 days out from Culpepper Island and the 519th day of the voyage.

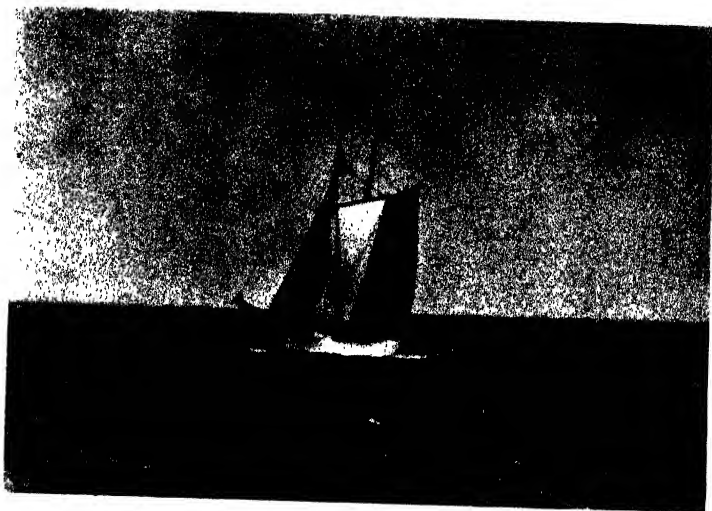


Fig. 1. When the tug *Relief* dropped us off the San Francisco lightship and the schooner's head was turned towards the south we did not see civilization again for seventeen long months.

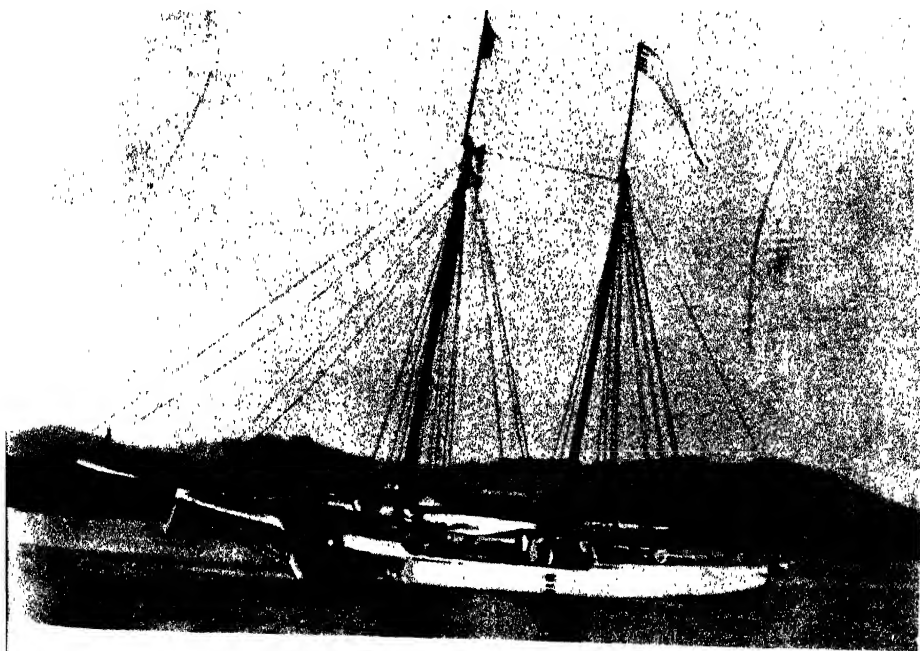
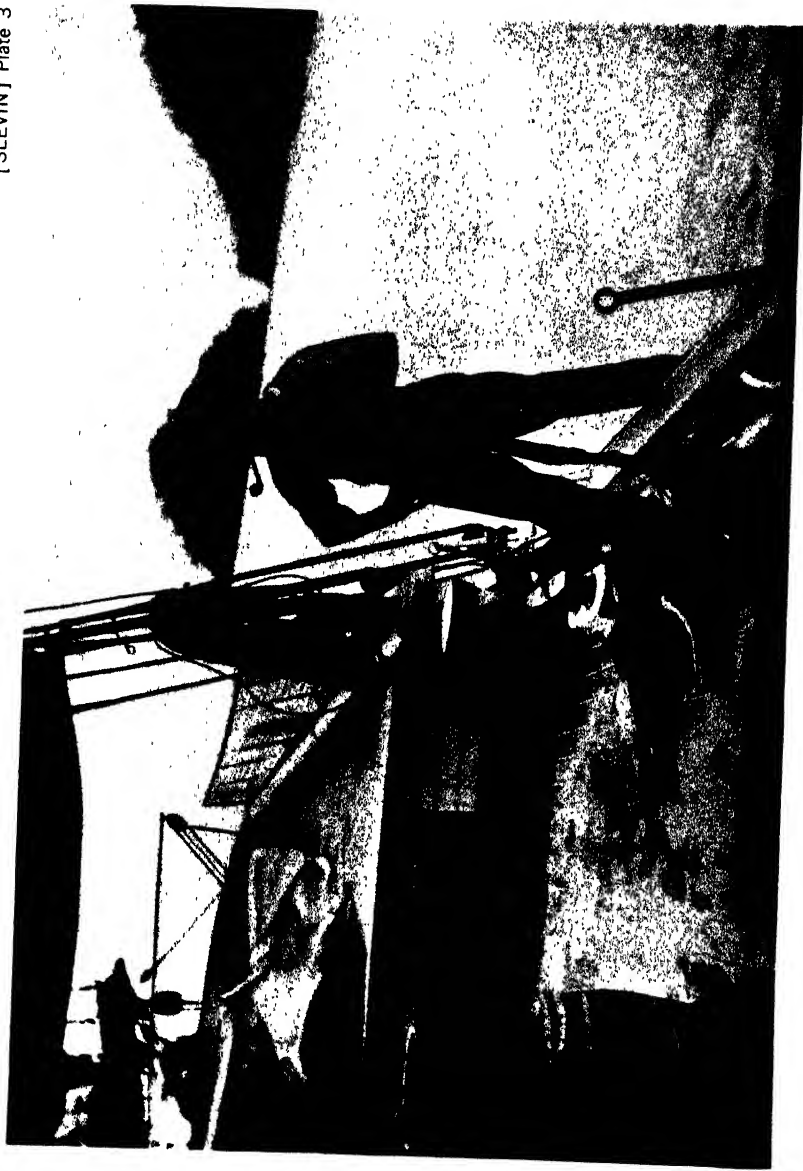


Fig. 2. Schooner *Academy*.



It was at his little plantation on Cocos Island that Captain and Mrs. August Gissler gave us a royal welcome on the 4th of September, 1905.



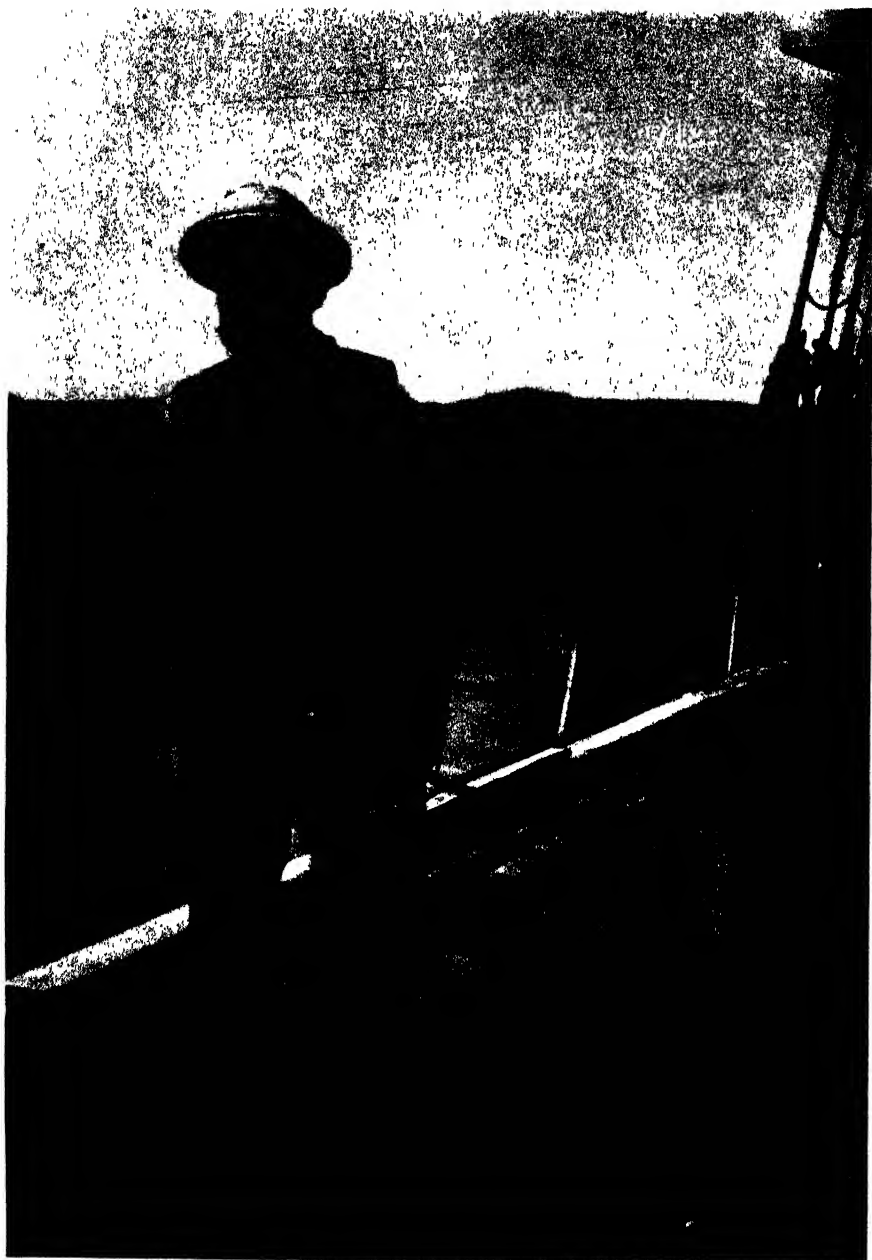
Nelson, our Mate, was fond of hunting and more than one Cocos Island pig fell before his trusty shotgun and his homemade buckshot.



On Hood Island the wild goats come down to the beach and drink the ocean water.



At Black Beach Roads we met a party of natives from the settlement on Chatham Island, who came over to hunt wild cattle and jerk the beef.



F. X. Williams, Entomologist of the expedition, is all ready for a run ashore.



The lagoons on Indefatigable Island abounded with Green Turtles and real turtle soup was not a luxury.



Packing tortoises through the jungle of Indefatigable is no child's play.



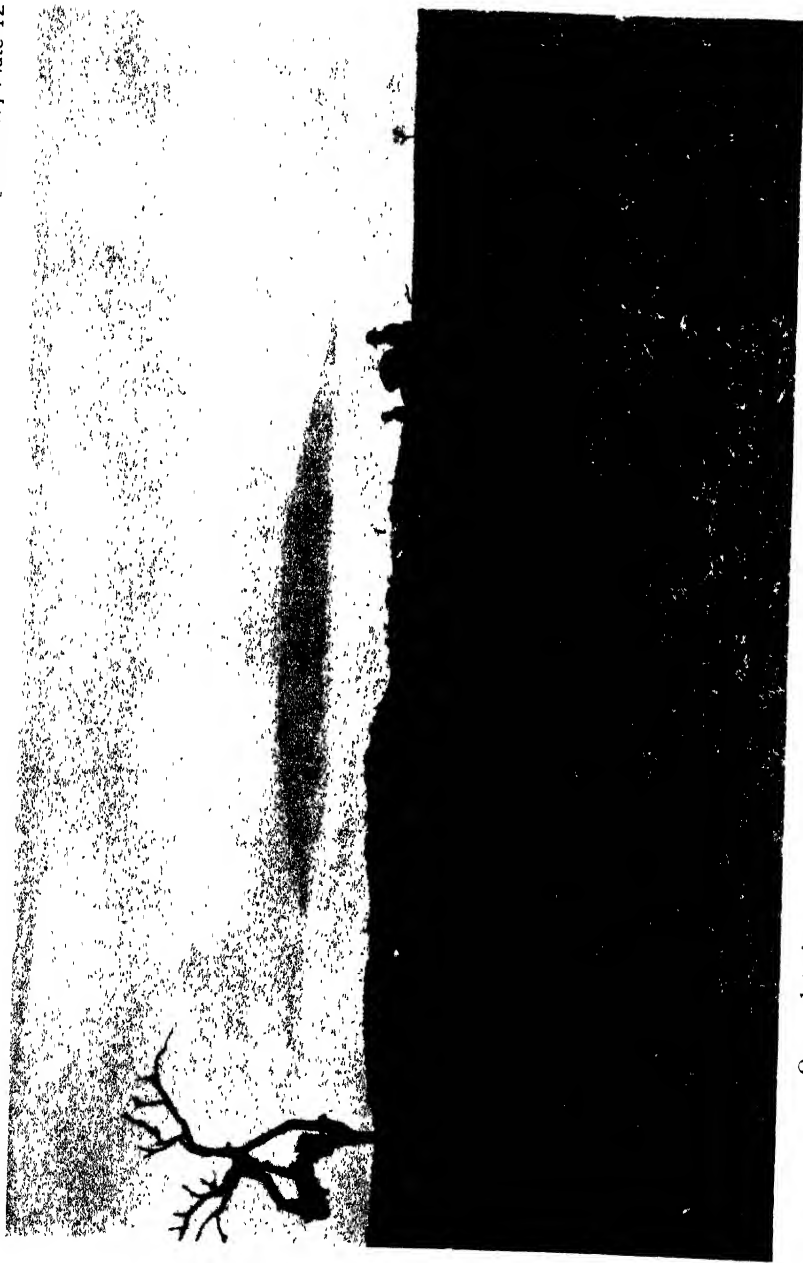
Coming down the cliffs a little extra assistance is necessary.



Going through the brushy country of the lower levels is not so bad after a trail is cut.



Nearing the beach the country becomes more open and, by packing in short relays, we made up for the time lost coming through the jungle.



Our pack train on top of the south rim of the crater of Yilamil Mountain. In the distance can be seen the north rim of the crater with a bank of fog in between.



At the foot of a tree, on top of Vilamil Mountain, we found a large sized tortoise.



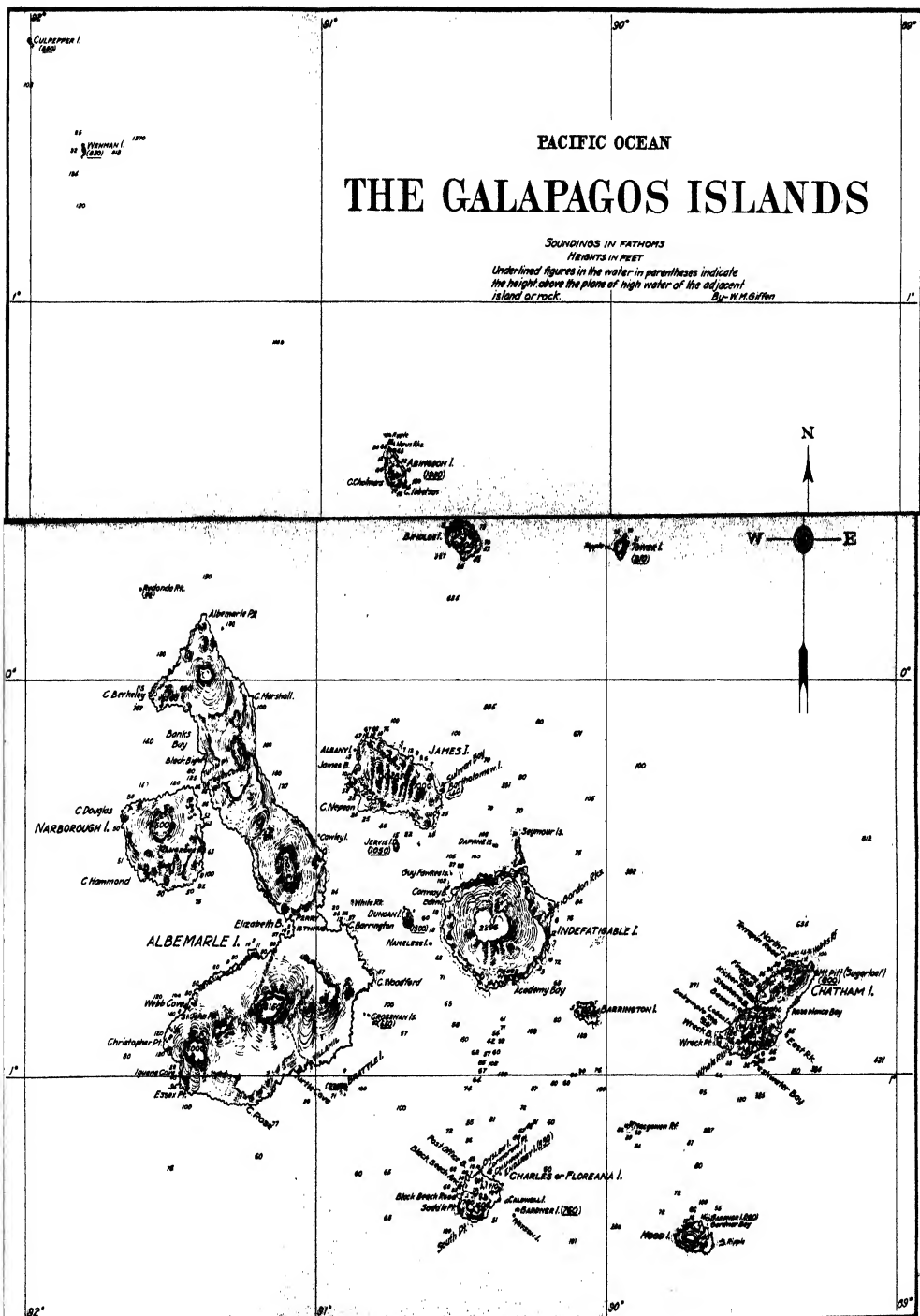
A giant tortoise as we found it in its native haunts at the base of Iguana Cove Mountain



We had a luxurious camp on Duncan Island. The pet hawk, standing on the dead tree, was fed turtle meat every day and became quite tame.



Land iguanas are common on Narborough Island and we found them clear to the rim of the crater.



Occasional Papers

OF THE

CALIFORNIA ACADEMY OF SCIENCES

XVIII

PRINTED FROM THE
JOHN W. HENDRIE PUBLICATION ENDOWMENT

SAN FRANCISCO
PUBLISHED BY THE ACADEMY
JUNE 29, 1931

THE AVIFAUNA
OF THE
GALAPAGOS ISLANDS

BY

HARRY S. SWARTH

Curator, Department of Ornithology and Mammalogy

SAN FRANCISCO
CALIFORNIA ACADEMY OF SCIENCES

JUNE 29, 1931

COMMITTEE ON PUBLICATION

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CONTENTS

	PAGE
INTRODUCTION	5
Scope of this Report.....	7
Historical	10
Features of the Galapagos Avifauna.....	14
Check-List of Galapagos Birds.....	30
ACCOUNTS OF THE SPECIES...	33
LITERATURE CITED.....	272
INDEX	291

Subspecies described in this volume:

<i>Nesomimus parvulus wenmani</i>	129
<i>Geospiza septentrionalis nigrescens</i>	185
<i>Cactospiza pallida striatipecta</i>	245

THE AVIFAUNA OF THE GALAPAGOS ISLANDS

INTRODUCTION

In the years 1905-1906 the California Academy of Sciences, under the directorship of Leverett Mills Loomis, sent an expedition to the Galapagos Islands to study and collect of the fauna and flora thereof. The expedition left San Francisco on June 28, 1905, and returned on November 29, 1906. A full year (September 24, 1905, to September 25, 1906) was spent in the Galapagos Archipelago, and a ten day visit (September 3-13, 1905) made to Cocos Island, Costa Rica*. Birds were collected by R. H. Beck, E. W. Gifford, J. S. Hunter, and E. S. King, 8691 specimens in all. Of this collection about 5800 are land birds of the Galapagos Islands and of Cocos Island, and it is with these land birds that this study is primarily concerned.

Several reports based upon this same collection and covering, systematically, all of the water birds and the one species of pigeon, have already appeared (see Gifford, 1913; Loomis, 1918). Circumstances prevented Mr. Gifford from completing this study as had been planned, and for many years the cases containing the series of land birds remained undisturbed.

When I was appointed curator of the Department of Ornithology and Mammalogy in the Academy, March 1, 1927, it was with the understanding that of first importance among my duties was the completion and publication of a report, primarily taxonomic, covering such part of the Galapagos avifauna as had not been studied by Gifford and Loomis. This proved to be a far lengthier and more arduous undertaking than was anticipated. The collection is considerably larger than any previously brought from the Archipelago, and the wealth of material, besides creating difficulties in the mere handling of innumerable specimens and the proper assembling of the facts presented, developed a disturbing tendency

*For detailed itinerary see: "Log of the schooner *Academy* on a voyage of scientific research to the Galapagos Islands, 1905-1906", by Joseph R. Slevin. Calif. Acad. Sci., Occasional Papers no. 17, 1931.

to upset previously published conceptions that had been comfortably established upon the evidence of a few specimens. At an early stage in the work I borrowed from the Stanford University Museum a large part of the bird collection resulting from the Hopkins-Stanford Galapagos Expedition, including all of the Geospizidæ and all *Nesomimus*, so that I had available the extensive series upon which Snodgrass and Heller (1904) had based their conclusions. I was generously permitted to keep these skins for the many months that it seemed desirable to do so.

My study reached a point where it became apparent that a satisfactory end could not be attained without examining more of the material of former writers, notably the birds collected by Darwin that served Gould as the basis for the first published descriptions of Galapagos species. Perhaps four-fifths of the types of birds described from the Galapagos are contained in the British Museum, in the Rothschild Museum at Tring, England, and in the United States National Museum, mostly in the first two institutions. In the spring of 1930 it proved possible for me to make the necessary trip, and I visited the British Museum and the Rothschild Museum in the interval between April 27 and June 13, and the United States National Museum on my way home the latter part of June, having abundant opportunity to examine all of the Galapagos material in those several institutions.

This report could not possibly have been concluded satisfactorily without examination of those specimens, and to the several institutions wherein the collections are placed I owe a debt of gratitude for the favors I have received in this connection. By the authorities of the British Museum (Natural History) I was granted the privilege of working in the Bird Room during the long period necessary for a protracted study of the many Galapagos types in that collection. Dr. P. R. Lowe, in charge of the collection, his associate Mr. N. B. Kinnear,* and their assistant, Mr. H. B. Usher, by their cordial co-operation and assistance made of my visit there a pleasurable experience, terminated with reluctance at the conclusion of my work. Similar courtesies received from Lord Rothschild opened to me the remarkable collections in his museum at Tring, where I also benefited by the invaluable assistance of his aide, Mr. A. T. Goodson. Again, at the United States

*Mr. Kinnear has, furthermore, in the interests of accuracy, checked up in the proof of this report on all references to specimens in the British Museum. Additional information thus obtained is entered as footnotes followed by the initials, N.B.K.

National Museum, through Dr. Alexander Wetmore, Assistant Secretary of the Smithsonian Institution, and with the assistance of Dr. Herbert Friedmann, Curator, and Dr. Charles W. Richmond, Associate Curator, Division of Birds, I was enabled to examine the abundant pertinent material therein, and also to borrow for longer study the several types and other unique specimens for which I asked. From the American Museum of Natural History, New York, through Dr. F. M. Chapman, I received the loan of South American mainland birds needed for comparison. For information regarding Galapagos birds in the Royal Natural History Museum, Stockholm, I am indebted to Dr. Einar Lönnberg, Director, and for the facts pertaining to the one Galapagos bird type in the Museum National d'Histoire Naturelle, Paris, I am similarly indebted to Mons. J. Berlioz, in charge of the bird collection thereof. My indebtedness to Dr. Casey A. Wood is no small one, for in his wide and intimate acquaintance with men, collections, and libraries the world over there has been a mine of information that has always been available to me, and that has been invaluable in the present study. The drawings of *Geospiza magnirostris* and *G. dentirostris* are the work of Mr. Henrik Grönvold, to execute which he generously interrupted the course of some far more interesting painting in which he was engaged. The chart on page 139 and the several graphs were drawn by Miss Margaret W. Wythe; the rest of the drawings are from the pen of Mrs. Frieda Abernathy, of Berkeley, California. The map used in delineation of ranges was drawn by Mrs. Mary E. Davidson, Assistant Curator in this department, who has also helped importantly in many other ways throughout the course of this study.

SCOPE OF THIS REPORT

The attempt has been made to consider herein every bird species with a valid claim to inclusion in the Galapagos list, with, in addition, the four resident land birds of Cocos Island, Costa Rica. The latter seem obviously to be part of the problem of the relationships and origin of the Galapagos avifauna, and so deserving of mention here, while the water birds of Cocos and vicinity have no such claim upon our attention. At the outset this study was intended to include no more than the species not already covered by Loomis and Gifford, and to a great extent this is the plan that has been followed. It seemed desirable, though, to have in one place a complete catalogue of the birds of the Galapagos Archi-

pelago compiled in the light of most recent findings, and the work was extended accordingly. Then, with the exceptional opportunities that I have had, both in our own extensive collection of Galapagos birds and in the chance to examine many of the specimens upon which previous writers based their conclusions (and I have seen nearly all of the types described from the islands), it seemed desirable to make this study something more than a brief report upon our own material, to endeavor, in fact, to have included within one set of covers a fairly comprehensive account of the Galapagos avifauna. So, beside my own personal contribution toward the taxonomy of the several groups, I have attempted, through the bibliography, synonymies and in other ways, to make available such information as has been published on other phases of Galapagos ornithology. It is my hope that others may find it useful to have here conveniently in one place, the answers to queries, or at least statements of current opinion, regarding matters whereof the original documents are in many cases scattered and difficult to find.

The order in which the species are listed is that given in Wetmore's "A systematic classification for the birds of the world" (Proc. U. S. Nat. Mus., vol. 76, art. 24, Jan. 8, 1930). While for the most part I have not gone into detail regarding species covered by Loomis and Gifford, there are certain phases of the subject that they ignored and these gaps I have filled out throughout the list. Then, too, regarding some of those species, the additional material that I have been able to examine has led me to amplify or to differ from Gifford's conclusions and I have stated my findings accordingly.

Manner of treatment is as follows: (1) The accepted name of the species. (2) A synonymy, not intended to be "complete", but giving citations to such publications as contain first-hand facts; general works and compilations are as a rule not included. (3) Data regarding type specimens, including all forms (accepted names and synonyms) that have been described from the territory here covered; data copied from the label are given first, further information or comment in parentheses or below. The method of handling this subject matter has been modeled after Bangs' "Types of birds now in the Museum of Comparative Zoology" (1930). (4) Habitat, in general terms for wide-ranging species, in greater detail for birds restricted to the islands. (5) The number of specimens collected by the Academy expedition, with the running numbers by which they

are listed in our departmental catalogue. The above items are generally not given by Loomis and Gifford, and they are entered here for every species. They are followed by whatever comments the different series suggest. This report is purely taxonomic and life histories and habits are not considered. The present writer has had no field experience in the Galapagos, and in any event Gifford's publication upon the life histories of the entire list is based upon this same collection.

Descriptions have been drawn up for some species and not for others. Where accurate and detailed descriptions have been published in works that are easily accessible (for example, Ridgway's [1907] treatment of *Nesomimus*) a reference to the book is considered sufficient.

All measurements in this paper were taken by myself, so that uniformity is assured in making comparisons. It was not possible to repeat each measurement, as might have been desirable for greater accuracy (a thousand or more specimens were measured), but in every column the extremes were gone over several times. Measurements are in millimeters; those that might be taken by different methods were obtained as follows:

Length of wing.—A straight line from bend of closed wing to tip of longest primary, with those feathers in their natural position (not straightened).

Length of tail.—From point of insertion of middle rectrices to tip of the longest.

Culmen.—Measured in a straight line from a point where the feathers cease to hide the culmen, to tip of maxilla; the chord of the exposed culmen.

Depth of bill.—From base of culmen to angle formed by feathers at lower edge of ramus of mandible.

Width of bill.—Measured at base of lower mandible.

Tarsus.—A straight line from center of heel joint on posterior side to joint between metatarsus and middle toe on anterior side.

Middle toe with claw.—Measured along upper side, from joint between metatarsus and middle toe to tip of claw.

In the tables of measurements I have as a rule used ten birds of each sex from any one island where the series contained that many specimens, with the precaution of looking over the entire series with sufficient care to see that extremes were included. In some cases where it seemed desirable I took a given measurement of not only the entire extensive series in our own collection but

of all other specimens that became available to me elsewhere.

Color terms are from Ridgway's *Color Standards and Color Nomenclature*.

The bibliography has been compiled with some care, most of the entries therein being of publications that were consulted in course of preparation of this report. There is a voluminous literature pertaining to the Galapagos Islands, including many papers upon branches of science other than ornithology, and including books of travel with more or less casual mention of the islands and of their birds. The items that I have listed include everything that I could find containing some definite contribution to the ornithology of the Galapagos. The few publications that are not primarily ornithological in purpose contain, nevertheless, some subject matter bearing directly upon ornithological problems.

HISTORICAL

Our knowledge of Galapagos birds begins with Darwin's historic visit to the Archipelago in 1835, and with Gould's descriptions of the birds that Darwin collected, published from 1837 to 1841. It should be a source of satisfaction to ornithologists that it was observation of the peculiarities of these same birds that apparently first turned Darwin's attention toward those problems of evolution, whereby he so profoundly influenced subsequent human thought. Darwin's itinerary during the *Beagle's* cruise among the islands (compiled from the "Narrative") was briefly as follows: September 15, 1835, Chatham and Hood in sight. September 16, Hood Island; in afternoon Chatham Island. September 17-22, Chatham Island, September 23, Chatham to Charles. September 24-27, Charles. September 28, toward southwestern point of Albemarle. September 29, Elizabeth Bay, Albemarle. September 30-October 2, Tagus Cove, Albemarle. October 3, around north end of Albemarle. October 4, toward Abingdon (did not land). October 5-7, passing Abingdon, Bindloe and Tower. October 8-17; during this period Darwin, with a companion, remained upon James Island while the *Beagle* continued its surveys elsewhere. October 18, Albemarle, thence toward Abingdon. October 19, Abingdon. October 20, past Wenman and Culpepper and then westward.

Study of the itinerary shows that most of Darwin's collecting must have been done upon James Island, with much lesser periods upon Chatham, Charles and Albemarle. A fact that has been regretted by all subsequent students, and Darwin himself was the

first to deplore it, is that no exact data were kept regarding the specimens collected, the island where a bird was taken being in most cases not recorded. Of course that was a period antedating the elaborate technique that has been developed in the collection and care of natural history specimens. A few examples of a species were considered ample for any purpose in those days, and there was no such careful labelling of every specimen as is now the rule. It is conceivable that a general locality indicated upon a box or jar might have been regarded as sufficient information upon the entire contents thereof.

At any rate, Darwin's new discoveries were first described by Gould merely as from the Galapagos Islands. Later, in the general report upon the birds of the *Beagle* expedition, an attempt was made to indicate the island or islands upon which each species was found. In most cases the grounds for these decisions are not known, but it may well have been from verbal information given by Darwin to Gould. Of course, where only one bird or two were shot of a conspicuous species such as the Barn Owl such recollections may be accepted as accurate, but there are other cases where this is not the case. Thus, Darwin says of *Geospiza magnirostris*, "I have strong reasons for believing this species is not found in James Island." But he says of *Camarhynchus crassirostris*, "I am nearly certain that this species is not found in James Island", and as this species is now known to be common on James, his impression of the non-occurrence of *magnirostris* there should not be allowed to out-weigh the evidence contained in the character of his *magnirostris* specimens, which certainly resemble recently collected birds from James Island.

Then, although knowledge of Darwin's itinerary should be of help in determining the origin of some of the *Beagle* material, these facts, too, are subject to modification. Captain Fitzroy, commander of the *Beagle*, collected many birds himself, some of which, at least, were examined by Gould together with Darwin's series. The *Beagle*, or parties therefrom, visited various islands that Darwin did not set foot upon, so that Fitzroy's specimens* might have come from any part of the archipelago. Obviously, except for certain conspicuous and outstanding species and specimens, the source of these unlabelled specimens can only be determined insofar as the various specific or subspecific characters give the necessary information.

*7 from Charles Id., 13 from James Id., 2 from Chatham Id. N.B.K.

"The collections made by Darwin during the voyage of the *Beagle* passed into the Museum of the Zoological Society [of London], and were afterward acquired* by the British Museum. Unfortunately, a few of the types had either perished or were overlooked by Mr. G. R. Gray, when he made his selection, since they are not now in the National Collection" (Sharpe, 1906, p. 836; see also p. 514). Most of these birds were mounted, presumably for exhibition in the Zoological Society's Museum; when they were acquired by the British Museum they were dismounted and placed in the research series. As I saw them (in 1930) they mostly gave evidence of their former mounted state in the presence of wire in the legs and by their glass eyes. A few had merely been removed from the stands, with slight modification of the "mounted" attitude. Some were "study skins", more or less well made, that had never been in the taxidermist's hands. For the most part they showed little or no sign of fading from exhibition; worn plumage had evidently been so when the bird was collected. T. C. Eyton bought some of Darwin's skins at the dispersal of the Zoological Society's collection. Upon Eyton's death his own collection was scattered, and many skins purchased for the Salvin-Godman collection and by the British Museum. So that there are Darwin-collected bird skins in the British Museum bearing a variety of labels. I saw, too, in the Leiden Museum several Galapagos birds which, from the "make" of the specimens I judged to be of the *Beagle* collection, though their exact history I could not ascertain.

On none of the British Museum birds did I find any label or other paper known to have been written by Darwin or Gould. Labels were all of a later date, mostly attached after the specimens had left the Zoological Society's Museum. In a few cases labels had pasted upon them bits of written paper that had been removed from the stands on which the birds had been perched.

Fitzroy's specimens are entered in the British Museum records as presented by Sir W. Burnett and Admiral Fitzroy. "The specimens were collected by Admiral Fitzroy, a celebrated meteorologist of his time . . . Sir Wm. Burnett was the King's physician, and what he had to do with the presentation of a collection made by the Admiral, I have never been able to discover" (Sharpe, 1906, p. 323).†

*Purchased at the dispersal of the Society's Museum.

†Sir William Burnett was Physician-General to the Navy. N.B.K.

The next important bird collection from the Galapagos was made by Dr. Habel in 1868, to serve as the basis for Salvin's (1876) comprehensive study, "On the Avifauna of the Galapagos Archipelago." The type specimens here described eventually found their way, too, into the British Museum collection. Nowhere in ornithological literature nor upon specimen labels can I find the collector's name given other than as "Dr. Habel" or "Dr. A. Habel". The significance of the initial letter "A" is unknown to me. It was rather disconcerting to find at last his name given in full as Dr. Simeon Habel, as it appears in the Smithsonian Report for 1879 (p. 15) in acknowledgment of a gift to the United States National Museum.

Ridgway's "Birds of the Galapagos Archipelago" (published March 15, 1897) and the preceding descriptions of many new forms were based upon collections made by the naturalists of the *Albatross* in 1888 and 1891 (Prof. Leslie A. Lee, Mr. Charles H. Townsend and Mr. Thomas Lee), and by Messrs. Baur and Adams in 1891. The *Albatross* collections went to the United States National Museum. The bulk of Dr. Baur's collection, with the numerous type specimens, after the completion of Ridgway's studies was purchased by the Rothschild Museum, Tring, England. In 1897 the Webster-Harris Expedition visited the Galapagos on behalf of the Rothschild Museum, obtaining important collections that served as the basis of Rothschild & Hartert's "A review of the ornithology of the Galapagos Islands" (1899). Of the bird collection many specimens were later distributed to the British Museum and elsewhere, though most of the material, with the types, remains at the Rothschild Museum. The Hopkins-Stanford Galapagos Expedition (1898-1899), the personnel comprising Robert E. Snodgrass and Edmund Heller, made a large collection of birds for the Stanford University Museum, the basis for a published report by the collectors (1904). This completes the account of the more important ornithological collections to be made upon the Galapagos prior to the California Academy of Sciences Expedition in 1905-1906.

FEATURES OF THE GALAPAGOS AVIFAUNA*

The Galapagos Archipelago lies on the equator in the Pacific Ocean about 500 miles west of the coast of Ecuador, to which country politically it belongs. There are nine larger islands and a number of smaller ones. The Galapagos have been generally regarded as oceanic islands. Dr. G. Baur has argued at length to the contrary, asserting that the avifauna as well as other features of the archipelago point to a former land connection with the American continent. Van Denburgh, studying the reptiles, agrees with Baur that the Galapagos are the surviving remnants of a subsiding continental land mass, but most writers have felt obliged to explain the Galapagos fauna as having been established upon islands that were already existent as such. The Galapagos have yielded fossils of Pliocene age. As far as the birds are concerned, explanation of peculiarities of the avifauna is not dependent. It seems to me, upon acceptance of the subsidence theory, and there are many facts in opposition. In this connection see Rothschild & Hartert (1899, pp. 136-142) with whose conclusions I am generally in accord.

Assuming that the Galapagos Archipelago are oceanic islands, not very different today from what they were in ages past, we can imagine the fortuitous arrival thereon of the ancestral Geospizids, for example, at a very remote date. Their place of origin may be inferred from the present day occurrence of *Pinaroloxias inornata* (said to resemble certain West Indian Cærebidæ in some respects) upon Cocos Island, between the Galapagos and Panama, and from the manner in which masses of vegetation are known to be carried by ocean currents for great distances southward from the Panamic region toward Cocos and the Galapagos. Original settlement by birds of the ancestral type upon one or more of the large central islands might be followed by changes in different strains of their descendants, producing generalized types ancestral to the several genera and more strikingly differentiated species that are widely spread over the archipelago today. Wandering individuals of these several types would eventually reach many or few additional islands, there to develop more or less widely differentiated strains of the several major divisions. Natural results of such a mode of origin would be, as we see is actually

*This chapter in modified form was read at the Seventh International Ornithological Congress, Amsterdam, June 4, 1930.

the case, a greater number of forms upon the large central islands, fewer upon the outlying ones. For some reason Hood and Tower seem to have been peculiarly difficult of access (there is present day evidence to show that this is still the case), and the few forms that did succeed in becoming established upon those islands were probably very rigidly isolated there, practically exempt from later infiltration of the parent stock, and thus able to develop into the very strongly differentiated species that we find upon those islands today.

There are 108 species and subspecies of birds in the Galapagos list. Of these there are 89 that are breeding and resident upon the islands, 77 of which are confined thereto, 12 found elsewhere as well. Of the 89 breeding birds, 37 are of the Geospizidæ, the dominant group of land birds and of uncertain affinities.

The different bird groups show various degrees of differentiation. At one extreme there is the very distinct assemblage of Geospizids. Then, there are some peculiar genera of unquestioned acceptance, such as *Nesomimus*, and others that are in dispute, as *Nannopterum* and *Eribates*. There are many distinct Galapagoan species of mainland genera, as of *Pyrocephalus*, *Progne*, *Buteo* and others; at least one accepted subspecies of a mainland species, *Dendroica petechia*; several Galapagoan forms, as yet unnamed, that do, nevertheless, exhibit faintly impressed characteristics in island specimens (such as *Himantopus mexicanus*); and a brief list (including *Pelecanus occidentalis*, *Casmerodius egretta*, *Gallinula chloropus cachinans*, and *Coccyzus melacoryphus*) in which no variation from the parent stock has been detected. Whether these varying degrees of peculiarity in the several groups indicate relative remoteness of times of arrival upon the islands is questionable: with little doubt some groups and some species have developed and altered more rapidly than others. Present day distribution of species over the Archipelago may perhaps contain suggestions as to times of arrival.

The birds of the Galapagos, where relationships at all are shown, are unmistakably American in affinities, but the islands are remarkably destitute of the highly characteristic bird life of the adjacent coast of South America. Resemblances are almost all toward Central American, West Indian, or even North American species. Evidence of Atlantic coast affinities crops out over and over again, as for instance, in that the Flamingo of the Galapagos

is the West Indian form, not the Peruvian, and the Pelican the *West Indian species, not the Californian*.

The *Geospizids*, including the so-called Galapagos finches, in their curious variations, complicated inter-relations, and manner of occurrence, present many facts worth dwelling upon. I lump in the one group the "finches" and the "creepers" of the Galapagos, and *Pinaroloxias* of Cocos Island. There can be no doubt of the close relationship there. In this group there have been 67 specific and subspecific names applied, of which, in my opinion, about 40 are valid. Synonyms fall mostly into two classes, of names applied to single specimens of uncertain status, and of names applied to forms upon an island or islands as differing from a recognized and nearly related form elsewhere, and where I have been unable to appreciate the difference.

In the first category there are such names as *Geospiza denti-rostris* Gould, and *Cactornis brevirostris* Ridgway, the types of which are practically unique, and which, in my opinion are aberrant examples of *Geospiza fortis*. In several of the series in the Academy collection there are single specimens that in some one character (generally bill structure) depart just as widely from the most nearly related species. This happens sufficiently often to make it seem possible that notably different variants are appearing not uncommonly among these birds, but not necessarily perpetuating their peculiarities. This possibility, together with the wide range of variation in bill structure that appears in some of the species, has made me unwilling to recognize forms based upon one or two specimens that show even outstanding peculiarity in that one organ and in no other particular.

Other synonyms are found in names that have been applied to the form upon one island as differing *en masse* from a recognized form upon some other island or islands, and where I have regarded the described differences as imperceptible or as not sufficiently pronounced for naming. This has been an exceedingly difficult matter of discrimination, and I am not sure that I have been entirely consistent in my treatment. Variation in all degrees of accentuation occurs among series from different islands, and it is not at all easy to decide just what degree of an observed trend deserves the artificial (and perhaps unduly exaggerated) emphasis of a separate name. Perhaps the only consistent handling of the situation would lie in giving a separate designation to the representative of

each separate form upon every island, whether obviously different or not, a safe enough procedure in almost every case among birds so nearly sedentary as are these. Not caring to go to that length I have tried under each species to convey exact information as to variation upon different islands by descriptive accounts, adopting a conservative use of names to distinguish what appears to be the better defined forms. Intergradation between different extremes occurs to a bewildering degree, so as to render any system of nomenclature more or less of an artificial procedure.

In fact, it seems to me that any discussion centering upon the question as to what system the classification of these birds should follow, whether a given form is a species or a subspecies, or whether or not it is a "good" subspecies, is rather beside the mark, they so resolutely refuse to conform to the standards applied to continental species. A system of names regarded as labels to so many pigeon-holes of definite capacity is out of the question: for one thing it would at once lead to the farther extension of the list of species that are represented each by a unique type, most of which I believe are non-existent as species. Rigid adherence to accepted criteria for subspecific association of forms could be followed to absurd lengths. Certain writers have lumped the genera *Geospiza*, *Platyspiza*, *Cactospiza* and *Camarhynchus* in one genus and upon plausible grounds, but the same argument could be advanced for the inclusion of *Certhidea* as well. Furthermore, it would be just as possible to argue for the specific unity of all the forms concerned (from *Geospiza* to *Certhidea*), to regard them all as only subspecifically separate. Intergradation through individual variation can be traced between any of the extremes, though not always between forms that are geographically adjacent. There is abundant material on hand for ordinary purposes of classification, but most assuredly the facts demonstrated thereby do not lend themselves satisfactorily to interpretation through our current system. Whether the bewildering conditions existent among these island birds arise entirely from the presence of factors that are ordinarily absent from the surroundings of mainland forms, or whether they are due in part to an instability in rapidly succeeding generations such as is not commonly seen elsewhere, can not be said, but I incline to the latter view. In the system that I have adopted I have been concerned to present clearly what seemed to me to be the facts in the case, rather than to adhere strictly to technicalities of treat-

ment that to my notion might here be disregarded. Some inconsistencies will doubtless be found but I trust none that seriously interfere with presentation of the facts.

Of recent years there have been important studies of Galapagos birds by Ridgway (1897, 1901, 1902), by Rothschild & Hartert (1899, 1902), and by Snodgrass & Heller (1904), in all of which the Geospizidæ claimed a large share of attention. The treatments adopted by these authors differ in certain important respects, though all agree in regarding *Certhidea* as of the Mniotiltidæ, the remaining forms as of the Fringillidæ. Ridgway consistently avoids trinomials, regarding every form that is recognizable at all as a distinct species, and in the "finches" he recognized the genera *Geospiza*, *Platyspiza*, and *Camarhynchus*. Rothschild & Hartert and Snodgrass & Heller use trinomials freely, regarding slightly differentiated forms as subspecies, and they lump the three above-mentioned genera under the one name, *Geospiza*. It seems to me eminently desirable to recognize the several genera here differentiated, especially so in view of my recognition of the whole assemblage as a distinct family. *Geospiza*, *Platyspiza*, *Cactospiza*, and *Camarhynchus*, are groups that are better understood as separate genera, despite the intergradation of a sort that can be traced between some of them.

There are differences of habits that are fairly well correlated with *Geospiza* on the one hand, with *Platyspiza*, *Cactospiza*, and *Camarhynchus*, on the other. The species of *Geospiza* ("ground finches") are for the most part ground feeders, though the long-billed *scandens* and its allies (the "cactus finches") resort primarily to cactus (eating both fruit and blossoms) and to the introduced oranges and other fruits. *Platyspiza*, *Cactospiza*, and *Camarhynchus* ("tree finches") are tree dwellers, feeding on leaves, fruit and insects in the shrubbery, rarely on the ground. It is noticeable that it is in the more sharply differentiated species, such as *Geospiza debilirostris* (strictly terrestrial and with skulking, rail-like habits), and *Platyspiza crassirostris* (noticeably arboreal), that there is found the most rigid adherence to certain given surroundings. In certain abundant, widely distributed, and widely variable species, *Geospiza fortis* and *G. fuliginosa*, food requirements are not so rigidly restricted, these birds being noted as feeding chiefly on the ground, but also commonly in trees and bushes, among the rocks on the beaches, and even picking at carrion and

among the refuse of a camp. Many of the finches have turned to introduced oranges and other fruit, to such an extent, indeed, in one case (*G. scandens*), as to cause that bird to have spread in abundance into the humid zone on islands where oranges are established in that belt, while elsewhere, under primitive conditions, it is characteristic of the arid zone, dependant upon the cactus fruit.

Altogether, in many of the Galapagoan Geospizidæ there is seen a variability in physical characteristics and an adaptability in habits that argues well for their future. It is in striking contrast to the highly specialized development found in, and rigid requirements controlling, the avifaunas of oceanic islands elsewhere, of which the Hawaiian birds (often compared with those of the Galapagos) at once come into mind.

The mode and amount of variation in these birds suggest that various types of development are being pushed to extremes, and without the elimination of the connecting intermediates; the extraordinary variants that crop up in many of the series give an impression of a process of change and experiment going on. Such remarkable extremes of variation in bill structure as are seen, for example, in series of *fortis* or *fuliginosa* from any one of the larger islands, connected as they are by every intermediate stage, lie outside my experience with any North American mainland bird. All these features give trouble, of course, in any attempt at an orderly classification of the forms concerned.

I am aware that Ridgway (1897, p. 468) has stated: "I have failed to discover in the series of specimens from any one island a greater range of variation in measurements than often exists among an equal number of specimens of mainland forms." Ridgway's series were limited in number, however, and the much greater amount of material that is now available does show extraordinary variation as described. Furthermore, in Ridgway's restricted series, some groups of specimens to which he gave separate names are now clearly seen as different points, sometimes widely separated extremes, along lines of variation that are nowhere broken into separated segments.

Darwin has stated one objection to the theory of evolution through natural selection in the following words: "Why, if species have descended from other species by insensibly fine gradations, do we not everywhere see innumerable transitional forms? Why

is not all nature in confusion, instead of the species being, as we see them, well defined?" Various answers, more or less satisfactory, have been made to these queries, but here just the conditions that are predicated by Darwin are what seem to obtain among the very birds that first inspired his researches in evolutionary problems. There *are* "innumerable transitional forms" (and, also, aberrant individuals apparently departing in entirely new directions). There *is* a pronounced degree of confusion and some forms that we are obliged to treat as species are *not* well defined.

Snodgrass (1902), in his study of these birds, concluded that there was no correlation between food and the widely variable size and shape of bill. In other words, natural selection was eliminated as a factor in the production of the observed variations, and apparently justly so, for in the amount and sort of differentiation that is seen here, and in the extraordinary amount of intergradation, it is not apparent that there are useful adaptations, in the remarkable extremes nor any lessened fitness in the numerous intermediates. There are large bills and small bills, heavy bills and slender bills, among the ground feeding species of *Geospiza*, and also, pushed to nearly as great extremes, among the tree-frequenting genera.

In the classification of the *Geospizidæ* that is here followed I have used trinomials fairly extensively. These birds may be divided into groups of obvious similarity, and within these groups there are more or less closely resembling forms. It seems desirable to use binomials or trinomials, as the case may be, to express, mainly, degree of difference. Intergradation of characters occurs from one extreme of the family to the other, as noted by nearly everyone who has studied these birds, though it is not always between birds of geographically adjacent islands. It is, of course, a matter of little importance whether I designate a bird by binomial or trinomial, or place it in one genus or another, all this amounting to no more than the expression of my opinion of the bird's relationships. What I have expended much thought and effort upon, however, is the attempt to express clearly and thoroughly the conditions presented in each series from every island. The classification that I have adopted is the result of my translation of those facts, but my effort has been to present the evidence in full, likewise, so that others may judge for themselves regarding my conclusions.

In the distribution and manner of occurrence of Geospizidæ on the islands of the Galapagos there are several noteworthy features. It will be seen that the different forms arrange themselves in groups, and that these groups, in their different members (subspecies or closely related species), are distributed more or less widely throughout the archipelago. The avifauna of each island is composed of representatives of different groups, not of several representatives of any one group. (There are only one or two cases, as in the occurrence of *Camarhynchus pauper* and *C. psittacula* upon Charles, where this may be called into question.) It will be noted (see Fig. 18, p. 290) that the central islands have the greater number of species, 11 on James, 11 on Indefatigable, and 10 on Albemarle, as compared with 4 on Tower, 4 on Hood, 9 on Abingdon and 7 on Bindloe. It will be noted, too, that the islands with the fewest forms have the largest proportion of forms that are peculiar to them. Of the four Geospizidæ upon Tower Island, three are clearly distinct, while the fourth, *Geospiza magnirostris*, exhibits upon Tower Island the extreme of development in that form. Of the four species upon Hood Island, two are distinct.

It seems curious that, among the outlying islands, there should be as many "ground finches" upon the far distant Culpepper, and more upon Wenman, Abingdon, and Bindloe, than upon Tower and Hood, which are no farther from the main group, but this condition doubtless results from the same factor that has produced such sharply differentiated species among the few forms that have succeeded in reaching, or in surviving upon, the two last mentioned islands. There are 3 of these finches reported from Culpepper, 5 from Wenman, 8 from Abingdon, and 6 from Bindloe, as compared with 3 each from Tower and Hood. Wenman has been reached by stray individuals of *fortis* and *parvulus*, and Abingdon by *parvulus*, neither of which have wandered to Tower. It is worth noting that the one specimen of *fortis* at hand from Wenman Island (apparently the first reported from there) is not of the "*fratercula*" mode (the small sized form) occurring upon Abingdon and Bindloe, the nearest islands, but is exactly like the larger sized bird of more distant Albemarle Island. Altogether, the evidence goes to show a wandering of individuals of the several species of "finches" from island to island toward the north, but not to Tower, far distant in the northeast. In this connection it may be well to assemble here the scattered facts given by Gifford

(1919) pertaining to the wanderings of these birds. He saw finches flying between Hood and Gardner-near-Hood, and assumed that some were *Geospiza conirostris* (p. 226). Of *G. fortis*, one bird was taken at sea 3 or 4 miles west of Charles Island, flying north, on May 23; one was taken 20 miles south of Brattle Island, flying northwest, on June 6; two came on board the next day (pp. 230, 231). Of *G. fuliginosa*, single birds were seen on two occasions "on the small islet off northeast James"; they were "often seen flying between Hood and the adjacent Gardner"; and on several occasions they came aboard the vessel when it was anchored off shore (p. 237). One example of *G. scandens* came aboard 20 miles south of Indefatigable (p. 241). No *Platyspiza*, *Camarhynchus* or *Cactospiza* was seen at sea at any time, but the occurrence of *Camarhynchus p. parvulus* on Wenman and Abingdon is nevertheless apparently due to the casual wandering of stray individuals.

In *Geospiza* an all-black plumage, in *Platyspiza* and *Camarhynchus* a black-headed plumage, in most forms of *Certhidea* a chestnut-throated plumage, is regarded as the "perfect" or "fully mature" condition of the adult male. These plumages may be admitted to be the "perfect" stage of the adult male, but it does not follow that all males eventually reach those stages. It is a notable fact that a different percentage of males in this "perfect" plumage should occur upon different islands, and also that several species, not closely related, should be similarly affected upon the same island. But consider the following: There are eight forms of *Geospizidæ* upon Abingdon (omitting *Certhidea*), in which plumage condition is as follows in the series at hand: *Geospiza magnirostris*, 21 males, of which 5 are black, 16 streaked; *G. fortis*, 22 males, 3 black, 19 streaked; *G. fuliginosa minor*, 17 males, 4 black, 13 streaked; *G. difficilis*, 6 males, 4 black, 2 streaked; *G. scandens abingdoni*, 9 males, all streaked; *Platyspiza crassirostris*, 9 males, 3 black-headed, 6 streaked; *Camarhynchus habeli*, 8 males, 1 black-headed, 7 streaked; *Camarhynchus p. parvulus*, 1 streaked male.

It is thus apparent that on Abingdon Island the "perfect" plumaged males (black or black-headed) are extremely scarce in all but one of the species occurring there. Besides the evidence of our specimens there are many corroborative statements scattered through the literature. It is beyond belief that the large proportion of streaked males in the several Abingdon series is a fortuitous

circumstance, due merely to the chances of collecting; I am convinced that this represents actual conditions. In all probability there is an even larger proportion of high plumaged males in the collected series than there is among the living birds, for the black and the black-headed birds are more conspicuous than the others and are also especially likely to be pursued by the collector when but few of them are seen.

Bindloe is close to Abingdon, and the two are nearer to each other than to any other island, yet conditions on Bindloe are very different in that high-plumaged males are in the majority. Of the several species thereon, black and non-black males are represented in our series as follows: *Geospiza magnirostris*, 3 black, 1 streaked; *G. fortis*, 9 black, 3 streaked; *G. fuliginosa minor*, 8 black, 1 streaked; *G. scandens rothschildi*, 4 black, 3 streaked; *Platyspiza crassirostris*, 3 black-headed, 2 streaked; *Camarhynchus habeli*, 8 black-headed, 9 streaked.

On Chatham Island, again, there is a small proportion of high plumaged males in some forms. In *Camarhynchus parvulus salvini* (in which the ordinarily non black-headed condition has been used as a specific character), only 5 males show any black on the head as against 64 with none, and on none of those five is it as fully developed as on *parvulus* from other islands. Of *Platyspiza crassirostris* there are 2 black-headed males, 21 with no black. In *Geospiza fortis* and *G. fuliginosa* (the first with 39 black males, 19 streaked, the second with 44 black, 26 streaked) there is no strong leaning in either direction.

In contrast to those islands where the "immature" plumage preponderates we find the Barrington Island series: *G. f. fuliginosa*, 28 black, 2 streaked; in the Tower Island series: *Geospiza magnirostris*, 7 black, 3 streaked; *G. acutirostris*, 17 black, 1 streaked; in the Jervis Island series: *Geospiza magnirostris*, 20 black, 1 streaked; *G. f. fuliginosa*, 5 black, 2 streaked; *G. s. scandens*, 5 black, none streaked. On James Island, with a strong preponderance of high plumaged males, the numbers of black and streaked males in our series are as follows: *G. magnirostris*, 23, 14; *G. fortis*, 16, 5; *G. f. fuliginosa*, 6, 2; *G. debilirostris*, 29, 0; *G. s. scandens*, 10, 0; *P. crassirostris*, 14, 6; *C. psittaculus*, 12, 0; *C. p. parvulus*, 10, 0.

There is an exasperating dearth of molting birds, showing transition from one stage to the other, but with such an absence of

streaked males as we find in the series of *acutirostris* from Tower Island, and *debilirostris* from James Island, for example, it seems likely that in those forms the streaked stage is frequently, perhaps almost invariably, not passed through.

So far from its being a proved fact that the black and the black-headed plumages of adult males of *Geospiza*, *Platyspiza* and *Camarhynchus*, respectively, are attained by every male bird after a preliminary streaked plumage that follows the juvenal stage, it is apparent that there are several other conditions that may obtain. It may be that in some cases the black and the black-headed plumages appear as color phases, occurring in some individuals throughout their lives while others remain streaked. This seems especially probable in certain of the black-headed species, where some juveniles are black-headed, others not.

In other words, instead of any one bird always passing through various intermediate stages for several years before reaching the "perfect" plumage, it seems more likely that the extent of blackness that is reached varies with, and is inherent in, the individual to some extent, in the aggregation of birds upon different islands in general character, and that the degree of perfection that is attained is reached very quickly, either with or without a preliminary year spent in the entirely streaked female plumage. There are islands where most male birds apparently do not pass through the streaked stage before attaining perfect plumage, others where most male birds apparently never pass beyond the streaked stage.

In the genus *Camarhynchus* there are two distinct types of plumage that are common to the female and the non-perfect male, one type more or less streaked, the other immaculate below. I have not been able to ascertain the significance of these plumages. A young *pauper* at hand is molting from the streaked juvenal stage into an immaculate-breasted plumage. Yet there are plenty of specimens in the series in later stages (breeding birds) with streaked underparts. In the *parvulus* series, too, breeding birds (non black-headed males and females) are about equally divided into streaked-breasted and immaculate. A plain plumage, unmarked below, occurs also in some forms of *Geospiza*, but much more rarely than in *Camarhynchus*.

The color variations just described, though fairly consistent on any one island, are erratic as regards the archipelago as a whole, but there are certain trends of variation that seem to pursue definite

lines. Thus, in *Geospiza magnirostris* the largest billed birds are at the north and size diminishes steadily toward the south; of birds in the streaked plumage, those from the northern islands average darker and more heavily marked than those from the southern ones. In *G. fortis* and in *G. fuliginosa*, as regards size of bill, the reverse is the case, those with the smallest bill being at the north, the largest to the southward. Coloration, however, in *fortis* and *fuliginosa* varies in the same way as in *magnirostris*, though in a lesser degree, with the northern birds in streaked plumage on the average somewhat darker than southern ones. In the non-black plumages of the several species there are differences between the series of the same form from different islands in the relative grayness, green-ness, or olivaceous tinge of the generally gray or brown color tone, but I am not sure that there is any general trend toward the same tinge in several forms from any one island.

Snodgrass & Heller (1904) outline six different phases of plumage ("stages") which they claim represent an orderly development throughout the group and which they use as a basis for their classification. I am not able to follow them in their conclusions. The different plumages are accurately described, but I find no evidence in their report or in their specimens to show that the age period of these plumages (except the juvenal) is established upon any definite knowledge of the age of the birds described. Their theory is, briefly, that the plumages of these "finches" show a progression from a primitive plain buffy-yellow color upward through streaked and black-headed stages, to an entirely black condition. The plain colored *Cactospiza* are placed at the bottom, and adult *Geospiza conirostris* (with black male and blackish female) at the top, with the young of the several intermediate stages all described as reverting each to an immediately lower stage.

The much more abundant material that is now at hand shows wide departures from their proposed arrangement. The young (juvenal) plumage of *Cactospiza pallida*, for instance, is heavily streaked, to become plain later in the adult. The juvenal plumage of certain forms of *Camarhynchus* is distinctly streaked and frequently black-headed, though in later stages an unmarked plumage occurs. These and other peculiarities of plumage render it impossible to accept these authors' diagrammatic arrangement of species.

It was a disappointment to find that our own enormous collection of *Geospizidæ* did not suffice to establish the progressive changes of plumage in the several species, from young to adult, and from males in the female-like plumage to the higher stages. This is due primarily to the fact that the collectors did not determine the age of specimens as based upon condition of the skull, as can be done in such birds for some months beyond the juvenal stage, and also because very few molting birds were collected. Ridgway (1901) and Snodgrass & Heller (1904) describe "young," "immature," and other stages for certain of the species, but in our own large series I find so many facts contradictory to the assumption of any given age for certain of the described plumages that I can not agree with their conclusions nor can I indicate any positively ascertained line of development in the individuals of any one species. This, however, could probably be done with relative ease by the collecting, not of vastly greater series of specimens, but of a few birds carefully selected and at the proper seasons, and with their ages definitely ascertained.

Certain facts do stand out in our collection that advance our knowledge of conditions to some extent. I regard it as proved that in adults of both sexes the bill changes color seasonally, being black during the breeding period, pale colored at other times. Color of bill in these birds has heretofore been described either as a specific character, as a sexual or age character, or as being individually variable and without any particular significance. There is one exception to this statement in that Sharpe (1888, p. 6) expressed his belief that the bill changes color with different seasons, but he coupled this with a conviction of seasonal change in plumage, too. I think that there can be no doubt that changing color in the bill is partly with age and partly with the seasons. With age in that the juvenal bill is pale colored in both sexes; in breeding birds (both sexes) the bill becomes black, reverting to a pale color at the close of each breeding season. In this conviction I have been careful to give the details of conditions in every series, so that others can weigh the evidence for themselves. The nesting season with these birds seems to be for the most part from early November to early April, and black-billed birds are almost invariably collected at that time. There are some slight discrepancies, but they may be explained as due to variations in the breeding season upon different islands, or it

may be the case that all individuals upon one island are not engaged in breeding activities throughout the entire length of the extended nesting period. At any rate, every one of the many specimens that are marked as associated with nest or eggs has a black bill. There is this further qualification to be made, too, that in the larger billed birds (such as *magnirostris*) the bill rarely becomes entirely pale colored in the adult, retaining a partly dusky appearance throughout the year, though much less black after the close of the nesting season.

It seems evident that, following the post-juvenal molt, there is but one molt during the year, in the period immediately following the nesting season, during April and May for the most part. The post-juvenal molt takes place at about the same time. Allowing for different breeding seasons, this is a condition common to many Passerine birds.

Regarding the relationships of the Geospizidæ to other groups elsewhere (American or Polynesian), as to position of the family in the general scheme of avian classification, I have no new ideas to offer. It seems to me that the statement of Rothschild & Hartert (1899, p. 153) that "the South American members of the genus *Guiraca* . . . are . . . the nearest relations to *Geospiza*" has no more to support it than incidental resemblance in shape of bill between certain species of the two groups, and can be dismissed with exactly the words those authors (*loc. cit.*) use in denying such relationship between *Geospiza* and some Hawaiian birds: "The resemblance with certain thick-billed Hawaiian finches, such as *Telespiza*, cannot have any serious consideration, as indicative of real relationship." Salvin's (1876, p. 488) assertion of resemblance between *Camarhynchus* and the Peruvian genus *Neorhynchus* has been denied by Ridgway (1897, p. 466), presumably on good ground; and Lucas' (1894) and Ridgway's (1897) assignment of *Certhidea* to the Mniotiltidæ seems to me to be a mistake. It will be noted that the above mentioned claims of relationship imply different mainland sources of origin for at least three of the genera of Geospizidæ. My own view is of close relationship between these several genera, so close as to imply their differentiation after the establishment of the ancestral Geospizid upon the Galapagos. It seems to me that the clue to the question may be found in the genus *Pinaroloxias*, which, as pointed out by Ridgway (1897, p. 466, footnote), offers various significant

facts in its specific characters and in its geographic location. This form, indubitably of the Geospizidæ, is, according to Ridgway, suggestive of certain West Indian Cœrebidæ in some respects, and its habitat, Cocos Island, is on a line of drift-sweeping currents known to extend from Panama southward toward the Galapagos.

Melanism in the Geospizidæ is probably a group character, and not a result of some peculiarity in the island environment. Though conspicuous in this one dominant group of birds, and also in the *Buteo* of the Galapagos, it does not commonly occur in other species. In fact, melanism might well be expected here in *Pyrocephalus*, as it occurs in a form of that genus in Peru, on the adjacent coast of South America. Its non-appearance in the Galapagos species may be interpreted as being due to their having a different origin, and also as indicating the absence from the Galapagos environment of any favorable stimulus to that condition.

Next to the Geospizids the most important bird group is the genus *Nesomimus* (Mockingbirds), peculiar to the Galapagos and distributed throughout the archipelago. There are four distinct species, three of them each restricted to one large island with its nearby islets, the fourth divided into a number of recognizable subspecies and distributed over many islands. The three first mentioned occur upon three large islands at the southeastern extremity of the archipelago, islands that are nearer to each other than to the rest of the group. Another variable genus is *Pyrocephalus* (Vermilion Flycatchers), which has developed one sharply distinguished species upon Chatham Island, a slightly variable species over the rest of the archipelago.

Then there are various other bird groups, mostly representatives of mainland genera, but nearly all distinct and sharply differentiated species, restricted to the Galapagos and showing various peculiarities of distribution. In several cases these are divided into clearly differentiated varieties upon different islands, and in nearly every other species there can be found upon one island or another some slight departure from the mode of its kind. I cannot see in the different bird groups any conformity in the ways in which species and subspecies of each have been developed. On the contrary, it looks much more as though the Geospizidæ, *Nesomimus* and *Pyrocephalus*, for example, had obtained their first foothold in the Galapagos at different points, perhaps at different times, and had accordingly each produced their most strongly

differentiated forms where varied circumstances governed. It is certainly true of Chatham Island, though, that there have been more or less conspicuous developments there in many different species, some of which are uniform over other islands.

Most of the outlying islands are small, with relatively few species. Chatham, however, is one of the larger islands, it is on the edge of the archipelago and it is rather remote from the others. As with the other large islands it has more bird species than the smaller islands, and as with the other outlying islands (all of which are much smaller) it has a large proportion of forms peculiar to itself. *Nesomimus*, *Certhidea*, and *Pyrocephalus* have all produced strongly characterized Chatham Island species. *Camarhynchus parvulus* and *Cactospiza pallida* have differentiated to the point where they can be accorded subspecific recognition, while *Butorides sundevalli*, *Myiarchus magnirostris*, and *Geospiza scandens intermedia*, all exhibit tendencies, not so far advanced, toward the development of certain characters peculiar to this one island.

In conclusion it may be said, and most emphatically, that, despite the enormous collections already accumulated therefrom, the Galapagos Islands offer an unrivalled opportunity for further field work. I am not alluding to the chance of discovering additional un-named species, as can probably still be done, nor does it seem desirable to pursue general collecting on a large scale. The work I have in mind could, some of it, be done by the visiting collector, spending relatively few weeks upon the islands, but the most promising lines of investigation are such as might be taken up by some one who could devote a period of years to almost or entirely continuous residence there. If large series of any one species should be collected they should be of selected forms and from selected localities, to provide correlations with similarly large series taken twenty-five or thirty years ago. My idea, though, of the sort of collecting that would be most apt to yield valuable data at once, is as follows: Of specimens taken two or three months subsequent to the breeding season, young and old after the post-juvenal and annual molts, respectively, with ages definitely ascertained from anatomical evidence; of molting birds in considerable number; of paired birds, and of whole families, parents and well-grown young together; and of specimens preserved entire for dissection. Specimens of these sorts are very scarce in collections. Then, there is need of careful observations not entailing the killing of

the birds; of censuses upon different islands showing relative abundance of species, and, especially, the ratio of high-plumaged males; of evidence of any sort bearing upon the inter-relations in life of the many closely similar forms. Lines of inquiry almost without number would open up with the beginning of any investigations of such nature.

There is a great opportunity here for some one, in the life study of a group of island birds, the Geospizidæ, of highly peculiar development as a result of ages of isolation. The especial attraction about this particular group is that, instead of being rigidly dependent upon circumscribed conditions, the pampered and helpless heirs of a secluded heritage, such as are the Drepanids of the Hawaiian Islands, the Geospizids seem to be a particularly virile and aggressive stock. Although different lines of development are pushed to remarkable extremes, they have not been proved to be adaptations, and unlike forms apparently pursue very similar sorts of lives. Much might be learned from carefully directed observations of the living birds amidst natural surroundings, and perhaps of the same species in captivity.

CHECK-LIST OF GALAPAGOS BIRDS

1. *Spheniscus mendiculus* Sundevall
2. *Diomedea irrorata* Salvin
3. *Pterodroma phæopygia* (Salvin)
4. *Puffinus obscurus subalaris* Ridgway
5. *Procellaria tethys* (Bonaparte)
6. *Oceanodroma castro* (Harcourt)
7. *Oceanites gracilis galapagoensis* Lowe
8. *Phaëthon æthereus* Linnæus
9. *Pelecanus occidentalis* Linnæus
10. *Sula piscator websteri* Rothschild
11. *Sula dactylatra granti* Rothschild
12. *Sula nebouxii* Milne-Edwards
13. *Nannopterum harrisi* (Rothschild)
14. *Fregata magnificens* Mathews
15. *Fregata minor ridgwayi* Mathews
16. *Ardea herodias cognata* Bangs
17. *Casmerodius egretta* (Gmelin)
18. *Butorides sundevalli* Reichenow
19. *Nyctanassa violacea pauper* (Selater & Salvin)
20. *Phœnicopterus ruber* Linnæus
21. *Querquedula discors* (Linnæus)
22. *Pæcilonitta galapagensis* Ridgway
23. *Buteo galapagoensis* (Gould)
24. *Pandion haliaëtus carolinensis* (Gmelin)

25. *Creciscus spilonotus* (Gould)
26. *Gallinula chloropus cachinnans* Bangs
27. *Hæmatopus palliatus galapagensis* Ridgway
28. *Squatarola squatarola* (Linnæus)
29. *Charadrius semipalmatus* Bonaparte
30. *Arenaria interpres interpres* (Linnæus)
31. *Pisobia bairdii* (Coues)
32. *Pisobia minutilla* (Vieillot)
33. *Crocethia alba* (Pallas)
34. *Tringa solitaria* Wilson
35. *Catoptrophorus semipalmatus inornatus* (Brewster)
36. *Heteroscelus incanus* (Gmelin)
37. *Actitis macularia* (Linnæus)
38. *Numenius hudsonicus* Latham
39. *Himantopus mexicanus* (Müller)
40. *Lobipes lobatus* (Linnæus)
41. *Steganopus tricolor* Vieillot
42. *Stercorarius pomarinus* (Temminck)
43. *Larus fuliginosus* Gould
44. *Larus pipixcan* Wagler
45. *Creagrus furcatus* (Neboux)
46. *Sterna fuscata crissalis* (Lawrence)
47. *Anous stolidus galapagensis* Sharpe
48. *Gygis alba* (Sparrman)
49. *Nesopelia galapagoensis galapagoensis* (Gould)
50. *Nesopelia galapagoensis exsul* Rothschild & Hartert
51. *Coccyzus melacoryphus* Vieillot
[*Coccyzus ferrugineus* Gould. *Cocos Id.*]
52. *Tyto punctatissima* (Gray)
53. *Asio galapagoensis* (Gould)
54. *Myiarchus magnirostris* (Gray)
55. *Pyrocephalus nanus nanus* Gould
56. *Pyrocephalus nanus intercedens* Ridgway
57. *Pyrocephalus dubius* Gould
[*Nesotriccus ridgwayi* Townsend. *Cocos Id.*]
58. *Progne modesta* (Neboux)
59. *Hirundo erythrogaster* Boddaert
60. *Nesomimus trifasciatus* (Gould)
61. *Nesomimus macdonaldi* Ridgway
62. *Nesomimus melanotis* (Gould)
63. *Nesomimus parvulus parvulus* (Gould)
64. *Nesomimus parvulus barringtoni* Rothschild
65. *Nesomimus parvulus bindloeii* Ridgway
66. *Nesomimus parvulus personatus* Ridgway
67. *Nesomimus parvulus wenmani* Swarth
68. *Nesomimus parvulus hulli* Rothschild
69. *Nesomimus parvulus bauri* Ridgway
70. *Dendroica petechia aureola* (Gould)
71. *Dolichonyx oryzivorus* (Linnæus)
72. *Geospiza magnirostris* Gould
73. *Geospiza fortis* Gould
74. *Geospiza fuliginosa fuliginosa* Gould
75. *Geospiza fuliginosa minor* Rothschild & Hartert

76. *Geospiza acutirostris* Ridgway
 77. *Geospiza difficilis* Sharpe
 78. *Geospiza debilirostris* Ridgway
 79. *Geospiza septentrionalis septentrionalis* Rothschild & Hartert
 80. *Geospiza septentrionalis nigrescens* Swarth
 81. *Geospiza scandens scandens* (Gould)
 82. *Geospiza scandens intermedia* Ridgway
 83. *Geospiza scandens abingdoni* Sclater & Salvin
 84. *Geospiza scandens rothschildi* Heller & Snodgrass
 85. *Geospiza conirostris conirostris* Ridgway
 86. *Geospiza conirostris propinqua* Ridgway
 87. *Platyspiza crassirostris* (Gould)
 88. *Camarhynchus psittacula* Gould
 89. *Camarhynchus habeli* Sclater & Salvin
 90. *Camarhynchus affinis* Ridgway
 91. *Camarhynchus pauper* Ridgway
 92. *Camarhynchus parvulus parvulus* Gould
 93. *Camarhynchus parvulus salvini* Ridgway
 94. *Camarhynchus aureus* Swarth
 95. *Camarhynchus conjunctus* Swarth
 96. *Cactospiza pallida pallida* (Sclater & Salvin)
 97. *Cactospiza pallida producta* (Ridgway)
 98. *Cactospiza pallida striatipecta* Swarth
 99. *Cactospiza giffordi* Swarth
 100. *Cactospiza heliobates* (Snodgrass & Heller)
 101. *Certhidea olivacea* Gould
 102. *Certhidea fusca* Sclater & Salvin
 103. *Certhidea becki* Rothschild
 104. *Certhidea mentalis* Ridgway
 105. *Certhidea ridgwayi* Rothschild & Hartert
 106. *Certhidea luteola* Ridgway
 107. *Certhidea cinerascens* Ridgway
 108. *Certhidea bifasciata* Ridgway
- [*Pinaroloxias inornata* (Gould) *Cocos Id.*]

ACCOUNTS OF THE SPECIES

1. *Spheniscus mendiculus* Sundevall

Spheniscus mendiculus Sundevall, 1871, pp. 126, 129 (James Id.; orig. descr.).—Salvin, 1876, p. 508, pl. 89.—Wolf, 1879, p. 297 (41) (Charles Id.).—Ridgway, 1890, p. 119 (Albemarle Id.); 1897, p. 660 (map of range).—Ogilvie-Grant, 1898, p. 653.—Rothschild & Hartert, 1899, p. 199 (Albemarle, Duncan and Brattle); 1902, p. 416.—Snodgrass & Heller, 1904, p. 235 (Seymour, Albemarle, Narboro; Wenman? Habits).—Gifford, 1913, p. 16, pl. 1, fig. 1 (Charles, Duncan, South Seymour, James, Narborough, Albemarle, Jervis, Onslow. Habits, description, measurements, etc.).—Gyldenstolpe, 1927, p. 106 (particulars of type specimen, in Royal Natural History Museum, Stockholm).
Spheniscus humboldtii Townsend, 1927, p. 509, pl. xxviii (actions in captivity).

SPHENISCUS MENDICULUS Sundevall

Type.—Royal Natural History Museum, Stockholm, no. 9797: ♂ ad.; James Island; May 10, 1852; "Eugenie" expedition.

HABITAT.—Vicinity of Galapagos Archipelago.

The Academy expedition of 1905-1906 collected 17 specimens (nos. 338-354). On a subsequent visit to the Galapagos by members of the Academy staff in December, 1927, and January, 1928, two adult male penguins were brought home alive. These lived for some months in the Steinhart Aquarium, dying, respectively, on July 7 and October 15, 1928, when they were preserved as study skins (nos. 31709, 31743).

2. *Diomedea irrorata* Salvin

"Two kinds of Albatrosses" Habel, in Salvin, 1876, p. 458, in text (Hood Id.).

Diomedea exulans Wolf, 1879, p. 269 (13), in text.

Diomedea irrorata Salvin, 1883, p. 430 (orig. descr.; "Callao Bay, Peru, December 1881."); 1896, p. 445, pl. viii.—Rothschild & Hartert, 1899, p. 192 (habits, descr., etc.); 1902, p. 414 (habits).—Godman, 1907-1910 (1910), p. 330, pl. 93 (mon.).—Snodgrass & Heller, 1904, p. 240 (descr. eggs, etc.).—Loomis, 1918, p. 75, pls. 6-12 (distr., habits, meas., etc.); 1919, p. 370, pls. 14-16 (variation).—Beebe, 1926, pp. 105, *et seq.*, 433, pls. (nesting habits).

? *Diomedea exulans* Ridgway, 1897, p. 646.

? *Diomedea nigripes* Ridgway, 1897, p. 647.

DIOMEDEA IRRORATA Salvin

Type.—British Museum, no. 88.5.18.165: ♂ ad.; Callao Bay, Peru; December, 1881; Captain A. H. Markham.

HABITAT.—Known to nest only on Hood Island, Galapagos Archipelago; extent of migrations elsewhere unknown, but occasionally, at least, to the adjacent coast of South America.

Seventy-three specimens were collected by the Academy expedition (nos. 1174-1246).

3. *Pterodroma phæopygia* (Salvin)

Cestrelata phæopygia Salvin, 1876, p. 507, pl. 88, fig. 1 (Chatham Id., Galapagos Archipelago; orig. descr.); 1896, p. 407.—Godman, 1907-1910 (1908), p. 207, pl. 56 (mon.).

Æstelata phæopygia Ridgway, 1897, p. 648.—Rothschild & Hartert, 1899, p. 198; 1902, p. 414.—Snodgrass & Heller, 1904, p. 242.

Pterodroma phæopygia Loomis, 1918, p. 97 (description, measurements, distribution, etc., Hawaiian and Galapagos birds declared to be indistinguishable).

CESTRELATA PHÆOPYGIA Salvin

Cotype.—British Museum, no. 59.1.31.20; ad., sex?; Chatham Island*

Cotype.—British Museum, no. 59.1.31.21; ad; sex?; Chatham Island.

Both received from Captain Kellett and Lieutenant Wood, as entered in the "Catalogue of Birds" (vol. XXV, p. 407), though no such notation is made upon the labels. No. 59.1.31.20 now carries a red "type label;" the description was based upon both skins.

HABITAT.—The Galapagos Archipelago; ? Hawaiian Islands. Extent of migration unknown.

The Academy expedition collected 181 specimens (nos. 928-1108).

4. *Puffinus obscurus subalaris* Ridgway

Puffinus obscurus Salvin, 1883, p. 431 (Charles Id.); 1896, p. 382.—Loomis, 1918, p. 122 (descr., habits, meas., crit.).

Puffinus subalaris Ridgway (ex Townsend MS.), 1897, p. 650 (Dallrymple Rock, Chatham Id.; orig. descr.).—Godman, 1907-1910 (1908), p. 117 (mon.).

Puffinus obscurus subalaris Rothschild & Hartert, 1899, p. 194; 1902, p. 241.—Snodgrass & Heller, 1904, p. 241.

Puffinus lherminieri subalaris Mathews, 1912, p. 70 (southern part of Galapagos Archipelago).

Puffinus lherminieri becki Mathews, 1912, p. 70 (Culpepper and Wenman islands).

Puffinus tenebrosus Townsend, 1890, p. 142; 1895, p. 126.

*With original label of either Kellett or Wood. Marked "type" in Salvin's handwriting. N.B.K.

PUFFINUS SUBALARIS Ridgway

Type.—United States National Museum, no. 117472; ♂ ad.; Dalrymple Rock, Chatham Island; April 6, 1888; C. H. Townsend.

PUFFINUS LHERMINIERI BECKI Mathews

Type.—Rothschild Museum; ♀ ad.; Culpepper Island; July 27, 1895; C. M. Harris (Webster-Harris expedition); orig. no. 184.

HABITAT.—Breeding upon the Galapagos Islands. Extent of migration elsewhere unknown.

The Academy expedition collected 109 specimens (nos. 814-922).

5. Procellaria tethys (Bonaparte)

Thalassidroma Tethys Bonaparte, 1853, p. 47 ("noch kleiner, als die *pelagica* ex Insulis Gallapagoes."). [See also Mathews, 1925, p. 12.]

Procellaria tethys Salvin, 1876, p. 507, pl. 88, fig. 2; 1896, p. 346.—Townsend, 1895, p. 126 (off Chatham Id. and 400 miles east of Galapagos Islands).—Ridgway, 1897, p. 656.—Rothschild & Hartert, 1899, p. 199; 1902, p. 416.—Snodgrass & Heller, 1904, p. 242.—Godman, 1907-1910 (1907), p. 4, pl. 2 (mon.).

Oceanodroma tethys Loomis, 1918, p. 151 (monograph).

HABITAT.—Breeds upon the Galapagos Islands. Its range "extends over the intertropical seas contiguous to the American west-coast" (Loomis, 1918, p. 152).

The Academy expedition collected 92 specimens (nos. 355-446).

6. Oceanodroma castro (Harcourt)

Oceanodroma cryptoleucura Townsend, 1895, p. 125 (Wenman Id.).—Salvin, 1896, p. 350.—Ridgway, 1897, p. 654.—Rothschild & Hartert, 1899, p. 198.—Snodgrass & Heller, 1904, p. 243.

Oceanodroma castro Rothschild & Hartert, 1902, p. 415.—Loomis, 1918, p. 156 (habits, meas., crit., etc.).—Godman, 1907-1910 (1907), p. 15, pl. 5 (mon.).

Oceanodroma castro bangsi Nichols, 1914, p. 388 ("Type. No. 12413. Collection of E. A. and O. Bangs. ♀. Collected 1° N. 93° W., February 6, 1901, by R. H. Beck.").—Bangs, 1930, p. 172 (particulars of type specimen, in Museum of Comparative Zoology).

OCEANODROMA CASTRO BANGSI Nichols

Type.—Museum of Comparative Zoology, no. 112413; ♀; Galapagos Islands, long. 93° W.; February 6, 1901; R. H. Beck.

HABITAT.—Vicinity of Galapagos Islands. Tropical and temperate seas, both in the Atlantic and Pacific.

The Academy expedition collected 35 specimens (nos. 485-488, 490-520).

7. *Oceanites gracilis galapagoensis* Lowe

Oceanites gracilis Ridgway, 1897, p. 658.—Rothschild & Hartert, 1899, p. 198; 1902, p. 416.—Snodgrass & Heller, 1904, p. 243.—Godman, 1907-1910 (1907), p. 48, pl. 13 (mon.).—Loomis, 1918, p. 180 (meas., molt, occurrence, etc.).
Oceanites gracilis galapagoensis Lowe, 1921, p. 140 (Charles Id.; orig. descr.).

OCEANITES GRACILIS GALAPAGOENSIS Lowe

Type.—British Museum, no. 99.9.1.523; ♂ ad.; Charles Island; November 4, 1897; Webster-Harris expedition.

HABITAT.—Galapagos Archipelago.

The Academy expedition collected 87 specimens (nos. 659-745), all from the Galapagos. There is no material from other points available for comparison.

8. *Phaëthon æthereus* Linnæus

Phaeton æthereus Salvin, 1876, p. 497 (Tower Id.).
Phaethon æthereus Ridgway, 1897, p. 600.—Rothschild & Hartert, 1899, p. 180 (Tower, Hood, Gardner and Culpepper islands); 1902, p. 409 (habits).—Snodgrass & Heller, 1904, p. 244.—Beck, 1904, p. 10, fig. (habits).—Gifford, 1913, p. 104 (throughout the Galapagos Archipelago).
Phaethon æthereus limatus Peters, 1930, p. 261 (Tower Island).

PHAETHON ÆTHEREUS LIMATUS Peters

Type.—Museum of Comparative Zoology, no. 65699; ♂ ad.; Tower Island; September 3, 1891; George Baur.

HABITAT.—Both coasts of tropical America.

The Academy expedition collected 78 specimens (nos. 2715-2792).

9. *Pelecanus occidentalis* Linnæus

Pelecanus fuscus Sundevall, 1871, pp. 125, 129.—Salvin, 1876, p. 496; 1883, p. 427 (Charles Id.).—Gifford, 1913, p. 107 (distr. in the Galapagos, habits, meas., etc.).
Pelecanus fuscus californicus Ridgway, 1897, p. 593.—Rothschild & Hartert, 1899, p. 176 (crit.; nest and eggs); 1902, p. 406 (nesting).
Pelecanus californicus Ridgway, 1890, p. 113 (Chatham Id.).—Grant, 1898, p. 478.—Snodgrass & Heller, 1904, p. 251 (distr. in Galapagos, colors of soft parts, meas., etc.).

HABITAT.—Coast of South Carolina south to Brazil, northern Peru and the Galapagos Islands.

The Academy expedition collected 10 specimens (nos. 2793-2802). Breeding adults from the Galapagos Islands have the neck light reddish in color, as compared with blackish in Californian and Lower Californian birds (*Pelecanus californicus*), which, according to Brewster (1902, p. 38), is one of "the most striking points of distinction between the two species."

10. *Sula piscator websteri* Rothschild

Sula piscator Ridgway, 1897, p. 598.

Sula websteri Rothschild, 1898a, p. lii (orig. descr.).—Beck, 1904, p. 8 (habits).

Sula piscatrix websteri Rothschild & Hartert, 1899, p. 177; 1902, p. 406.—Snodgrass & Heller, 1902, p. 515 (Cocos and Galapagos); 1904, p. 246.

Sula piscatrix Gifford, 1913, p. 85, pl. V, fig. 1 (occurrence on Galapagos, habits, meas., etc.).

HABITAT.—"Clarion Island, Galapagos, and the neighboring seas" (Rothschild, 1898).

The Academy expedition collected 58 specimens (nos. 2408-2465).

11. *Sula dactylatra granti* Rothschild

Dysporus cyanops Sundevall, 1871, p. 125 (Galapagos Islands).

Sula cyanops Salvin, 1883, p. 427 (Charles Id.).—Ridgway, 1897, p. 595.

Sula variegata Rothschild & Hartert, 1899, p. 178; 1902, p. 407.—Snodgrass & Heller, 1904, p. 244.—Gifford, 1913, p. 89.

Sula granti Rothschild, 1902b, p. 7 (orig. descr.).

Sula dactylatra granti Rothschild, 1915, p. 44.—Hartert, 1925, p. 274 (particulars of type specimen, in Rothschild Museum).

SULA GRANTI Rothschild

Type.—Rothschild Museum; ♀ ad.; Culpepper Island; July 29, 1897; F. P. Drowne (Webster-Harris expedition); orig. no. 126.

HABITAT.—Galapagos Islands.

The Academy expedition collected 69 specimens (nos. 2466-2534).

12. *Sula nebouxii* Milne-Edwards

Sula nebouxii Ridgway, 1897, p. 596 (distr. in Galapagos Ids., descr., etc.).

Sula nebouxii Grant, 1898, p. 435.—Rothschild & Hartert, 1899, p. 178 (distr. in Galapagos, eggs, etc.); 1902, p. 407.—Snodgrass

- & Heller, 1904, p. 248.—Beck, 1904, p. 6, fig. (habits.)—Gifford, 1913, p. 93, pl. 5, fig. 2 (plumages, eggs, meas., crit.).
Sula gossi Ridgway, 1890, p. 114, (Chatham Id.).
 ? *Dysporus leucogaster* Sundevall, 1871, p. 125.
 ? *Sula leucogaster* Salvin, 1876, p. 496.
 ? *Sula brewsteri* Ridgway, 1897, p. 597, part (Galapagos occurrences).
 —Rothschild & Hartert, 1899, p. 179.

HABITAT.—Gulf of California and southward to Galapagos Islands and coast of Chili.

The Academy expedition collected 65 specimens (nos. 2535-2599).

Genus NANNOPTERUM Sharpe

Nannopterum Sharpe, Hand-list of the Genera and Species of Birds, vol. 1, 1899, p. 235. (Type, *Phalacrocorax harrisi* Rothschild.)

13. *Nannopterum harrisi* (Rothschild)

- Phalacrocorax harrisi* Rothschild, 1898a, p. lii (Narborough Id.; orig. descr.).—Ogilvie-Grant 1898, p. 655.—Rothschild & Hartert, 1899, p. 179; 1902, p. 408, pl. X (habits).—Gadow, 1902, p. 169, pls. XIV-XV (osteology).—Beck, 1902, p. 20, text fig. (habits).—Snodgrass & Heller, 1904, p. 249 (habits, eggs, etc.).—Hartert, 1925, p. 274 (particulars of type specimen, in Rothschild Museum).
Nannopterum harrisi Gifford, 1913, p. 80 (habits, nesting, meas., etc.).—Shufeldt, 1915, pp. 86-114, pls. XV-XIX (osteology).

PHALACROCORAX HARRISI Rothschild

Type.—Rothschild Museum ♂ (not fully adult); Narborough Island; December 6, 1897; C. D. Hull (Webster-Harris expedition); orig. no. 2879.

HABITAT.—Galapagos Archipelago, where it is almost, or entirely, confined to the coast of Narborough and the adjacent coast of Albemarle Island.

The Academy expedition of 1905-1906 collected 27 specimens (nos. 2354-2380). On a later visit to the Galapagos by members of the Academy staff, five more were collected (one, entire, in alcohol), at Tagus Cove, Albemarle Island, December 12, 1927 (nos. 31338-31342).

14. *Fregata magnificens* Mathews

- Fregata aquila* Gould, 1841, p. 146, part ?.—Salvin, 1876, p. 497, part ? (Tower Id.).—Ridgway, 1897, p. 590.—Rothschild & Hartert, 1899, p. 175, part; 1902, p. 405, part ?.—Snodgrass & Heller, 1902, p. 516, part; 1904, p. 252, part.—Gifford, 1913, p. 100, pls. VI, VII, part.

Tachypetes aquilus Sundevall, 1871, p. 125, part.

Fregata minor magnificens Mathews, 1914, p. 120 (orig. descr.; "Barrington, Indefatigable, Albemarle Islands, etc.")—Hartert, 1925, p. 274 (particulars of type specimen, in Rothschild Museum).

Fregata magnificens Rothschild, 1915, p. 145.

Fregata magnificens magnificens Lowe, 1924, p. 303.

FREGATA MINOR MAGNIFICENS Mathews

Type.—Rothschild Museum; ♂ ad.; Barrington Island; July 8, 1891; Dr. G. Baur; orig. no. 259.

15. *Fregata minor ridgwayi* Mathews

Fregata aquila Gould, 1841, p. 146, part ?—Salvin, 1876, p. 497, part ? (Tower Id.).—Rothschild & Hartert, 1899; p. 175, part; 1902, p. 405, part? (Culpepper, Wenman and Tower islands, nesting).—Snodgrass & Heller, 1902, p. 516, part; 1904, p. 252, part.—Gifford, 1913, p. 100, pls. VI, VII, part.

Tachypetes aquilus Sundevall, 1871, p. 125, part.

Fregata aquila minor Ridgway, 1897, p. 591.

Fregata minor ridgwayi Mathews, 1914, p. 120 (orig. descr.; "Culpepper and Wenman Islands").—Rothschild, 1915, p. 145.—Lowe, 1924, p. 306, *et seq.*—Hartert, 1925, p. 275 (particulars of type specimen, in Rothschild Museum).

FREGATA MINOR RIDGWAYI Mathews

Type.—Rothschild Museum; ♂ ad.; Culpepper Island; July 27, 1897; C. M. Harris (Webster-Harris expedition); orig. no. 194.

In the Academy's series of *Fregata* from the Galapagos Islands it is easily possible to differentiate the species *minor* and *magnificens*, easily, that is, as regards the adults and some immatures, inferentially as regards most of the young birds. The characters pointed out by Mathews (1914), and especially by Lowe (1924), are readily apparent. This series of *Fregata* was reported upon by Gifford (1913, p. 100), as regards life history and habits, and, as it happens, he gives colors of some of the "soft parts" of birds from two different islands. The observed variations he ascribes, inferentially at least, to the one lot being in breeding, the other in non-breeding, condition, but the two lots, according to my view, are of two species. He remarks that "the colors of the naked parts of birds taken on Hood [= *F. minor ridgwayi*] . . . were as follows: Orbital ring black in adult males, red in adult females, and pale blue in immature birds. Bills were pale blue in all but adult males." Three adults taken at Academy Bay, Indefatigable Island, in July [= *F. magnificens*] were thus described: "Two were adult females with orbital rings dark blue, gular sacs purplish, and feet red. The remaining bird, an adult male, had a bright

SPECIMENS OF *Fregata magnificens* IN THE COLLECTION
OF THE CALIFORNIA ACADEMY OF SCIENCES

Number	Sex and age	Locality	Date
2678	♂ ad.	Indefatigable	July 21, 1906
2681	♂ ad.	Indefatigable	July 16, 1906
2707	♂ im.	South Albemarle	April 27, 1906
2680	♀ ad.	Indefatigable	July 20, 1906
2684	♀ ad.	Indefatigable	July 17, 1906
2688	♀ ad.	Duncan	Dec. 14, 1905
2686	♀ ad.	Duncan	Dec. 12, 1905
2687	♀ ad.	Hood	Sept. 28, 1905

SPECIMENS OF *Fregata minor ridgwayi* IN THE COLLECTION
OF THE CALIFORNIA ACADEMY OF SCIENCES

Number	Sex and age	Locality	Date
2679	♂ ad.	Hood	June 25, 1906
2683	♂ ad.	Hood	June 28, 1906
2689	♀ ad.	Hood	June 25, 1906
2690	♀ ad.	Hood	June 28, 1906
2692	♀ ad.	Hood	June 28, 1906
2693	♀ ad.	Hood	July 2, 1906
2694	♂ im.	Hood	July 2, 1906
2697	♂ im.	Hood	July 2, 1906
2700	♂ im.	Hood	July 2, 1906
2695	♂ im.	Hood	Sept. 28, 1905
2698	♂ im.	Hood	Sept. 28, 1905
2702	♂ im.	Hood	Sept. 28, 1905
2703	♂ im.	Hood	Sept. 28, 1905
2708	♂ im.	Hood	Sept. 28, 1905
2701	♂ im.	Lat. 14°11'N. Lat. 109°20'W.	Oct. 9, 1906
2696	♀ im.	Hood	June 28, 1906
2699	♀ im.	Hood	June 28, 1906
2706	♀ im.	Hood	June 28, 1906
2691	♀ im.	Hood	Sept. 28, 1905
2704	♀ im.	Brattle	Oct. 30, 1905
2705	♀ im.	Hood	July 2, 1906
2709	♂ nat.	Hood	Sept. 28, 1905
2710	♂ nat.	Hood	Sept. 28, 1905
2711	♀ nat.	Hood	June 25, 1906
2712	? nat.	Hood	June 25, 1906
2713	? nat.	Hood	June 25, 1906
2714	? nat.	Hood	June 25, 1906

red gular sac." The red feet of the adult female *magnificens* remain a distinguishable character of the specimens to the present time, twenty-five years after the birds were collected.

Both forms apparently occur throughout the Archipelago, but nothing is known as to the degree to which breeding colonies of the two are segregated, whether upon different islands, upon different parts of the same island, or whether individuals of both species nest side by side. From the localities of capture of the Academy series there is suggested general segregation of the two, with occasional individuals of each wandering into the territory of the other.

The Academy series includes 8 specimens of *magnificens* and 27 of *ridgwayi* (nos. 2678-2714).

16. *Ardea herodias cognata* Bangs

Ardea herodias Gould, 1841, p. 128.—Sclater & Salvin, 1870, p. 323 (Indefatigable Id.).—Salvin, 1876, p. 497.—Ridgway, 1890, p. 114 (Duncan Id.).—Sharpe, 1898, p. 80, part.—Rothschild & Hartert, 1899, p. 180 (Albemarle and Indefatigable islands); 1902, p. 410 (eggs).—Snodgrass & Heller, 1904, p. 254 (Seymour, Indefatigable, Duncan, Albemarle and Narborough; descr. nest and eggs).—Gifford, 1913, p. 58 (James, Duncan, Seymour, Indefatigable, Albemarle, Narborough, Charles, Hood and Chatham islands).

?*Ardea herodias* Ridgway, 1897, p. 601 (crit.).

Ardea herodias cognata Bangs, 1903, p. 100 (Indefatigable Id.; orig. descr.); 1930, p. 180 (particulars of type specimen, in Museum of Comparative Zoology).—Oberholser, 1912, p. 549 (monograph of the species).

ARDEA HERODIAS COGNATA Bangs

Type.—Museum of Comparative Zoology, no. 112,451; Indefatigable Island; February 16, 1901; R. H. Beck.

SPECIMENS OF *Ardea herodias cognata* IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES

Number	Sex and age	Locality	Date
2014	♂ ad.	Indefatigable	July 16, 1906
2019	♂ ad.	Indefatigable	July 18, 1906
2016	♂ ad.	Indefatigable	July 23, 1906
2020	♂ ad.	S. Seymour	July 26, 1906
2018	♂ ad.	Albemarle	Aug. 10, 1906
2017	♀ ad.	Indefatigable	Oct. 27, 1905
2013	♀ ad.	Indefatigable	July 23, 1906
2021	♂ im.	Indefatigable	July 16, 1906
2022	♀ im.	Indefatigable	July 16, 1906
2015	— nat.	Indefatigable	Oct. 27, 1905

HABITAT.—The Galapagos Archipelago, where it has been found on all the larger central and southern islands. So far not reported from Tower, Abingdon, Bindloe, Wenman and Culpepper.

17. *Casmerodius egretta* (Gmelin)

? *Herodias egretta* Ridgway, 1897, p. 601 (Albemarle Id., breeding).
Herodias egretta Rothschild & Hartert, 1899, p. 181 (Albemarle Id.).
—Snodgrass & Heller, 1904, p. 254 (Albemarle Id.).—Gifford, 1913, p. 59 (Albemarle and Indefatigable islands).

HABITAT.—Temperate and tropical America. In the Galapagos Archipelago it has thus far been reported only from Albemarle and Indefatigable islands.

The Academy expedition collected six specimens (nos. 2024-2029).

18. *Butorides sundevalli* Reichenow

Ardea Sundevalli Reichenow, 1877, p. 253.
Butorides sundevalli Sharpe, 1898, p. 185 (Charles and Indefatigable islands).—Gifford, 1913, p. 62 (distr., habits, crit., etc.).
Ardea plumbea Sundevall, 1871, pp. 125, 127 (orig. descr.; James Id.).
Butorides plumbeus Salvin, 1876, p. 497 (Indefatigable Id.); 1883, p. 428 (Charles Id.).—Ridgway, 1890, p. 114 (Hood, James, Duncan and Abingdon islands); 1897, p. 602.—Rothschild & Hartert, 1899, p. 181; 1902, p. 411.—Snodgrass & Heller, 1904, p. 255.
Butorides javanicus Sclater & Salvin, 1870, p. 323 (Indefatigable Id.).

ARDEA PLUMBEA Sundevall

Type.—Royal Natural History Museum, Stockholm; Galapagos; May 10-15, 1852; "Eugenie" expedition.

This specimen was not entered in Gyldenstolpe's "Types of Birds in the Royal Natural History Museum in Stockholm", but I am informed by Dr. Lönnberg that it is in the collection, with data as given above.

HABITAT.—The Galapagos Islands, where found practically throughout the Archipelago.

The Academy series numbers 102 specimens (nos. 2067-2168), as listed in the accompanying table.

There is a strong temptation to describe the Chatham Island bird as a subspecies distinct from typical *sundevalli*, as shown by the five skins in the Academy collection and two in the Rothschild

Museum. The differences are just those noted by Ridgway years ago (1897, p. 605), consisting of generally paler color in the Chatham Island specimens, with, on the fore neck, an accentuation of pale brown markings that are almost or entirely lacking on skins from other islands. One of the Chatham Island birds is slightly darker than the others, and there are two specimens in other series (one from Albemarle, one from Indefatigable) that approach the Chatham Island form in pallor. So I am refraining from affixing a name to this race, but it may be noted as illustrating an early stage of differentiation in an island population. Chatham Island has produced such a number of strongly marked forms among the variable species that it is not surprising to find one of the more stable species showing some change thereon.

SPECIMENS OF *Butorides sundevalli* IN THE COLLECTION
OF THE CALIFORNIA ACADEMY OF SCIENCES

	Male adult	Female adult	Male juv.	Female juv.
Abingdon	2	3	1	1
Bindloe		2		
James	3		1	
Jervis			1	
Duncan	2	1		
Narborough				1
Albemarle	5	3	1	2
Daphne	1	2		
Indefatigable	20	19	5	2
Seymour	1	2		1
Charles			1	
Barrington	1		1	
Gardner-near-Hood	4	2		1
Hood	3	1		1
Chatham	4	1		

19. *Nyctanassa violacea pauper* (Sclater & Salvin)

Nycticorax violaceus Gray, in Gould, 1841, p. 128 (a specimen from "the Gallapagos Archipelago").

Nycticorax pauper Sclater & Salvin, 1870, pp. 323, 327 (Indefatigable Id.; orig. descr.).—Salvin, 1876, p. 498 (Indefatigable and Bindloe islands).—Ridgway, 1890, p. 114 (Hood and Indefatigable islands).

Nyctanassa pauper Sharpe, 1898, p. 134, pl. I c (juv.).

Nyctanassa violacea paupera Rothschild & Hartert, 1902, p. 411 (Narborough Id.; descr. nest and eggs; crit.).

Ardea violacea Sundevall, 1871, pp. 125, 128.

Nyctanassa violacea Ridgway, 1897, p. 606 (crit.).—Rothschild & Hartert, 1899, p. 182.—Snodgrass & Heller, 1904, p. 255.—Gifford, 1913, p. 59, pl. II, fig. 1 (nest and eggs).

NYCTICORAX PAUPER Sclater & Salvin

Cotype.—British Museum, no. 1893.2.1.958; ♂ juv.; Indefatigable Island; August 30, 1868; Dr. A. Habel.*

Cotype.—British Museum, no. 93.2.1.957; ♂ juv.; Indefatigable Island; August 29, 1868; Dr. A. Habel.

Original description based upon both skins; no. 1893.2.1.958 now bears a red "type label."

HABITAT.—The Galapagos Archipelago, where it has been found upon practically all of the islands except the two northernmost, Culpepper and Wenman.

The Academy expedition collected 33 specimens of this species in the Galapagos Archipelago, three on Cocos Island, and one on Socorro, of the Revillagigedo group (nos. 2030-2066). These birds were variously collected during every month of the year except January, April and May.

To my eye, the Galapagos birds, old and young, as compared with those from Cocos Island and Mexican localities, present obviously enough the characters that have been pointed out by others as distinguishing the subspecies *pauper* from typical *violacea* (see especially Rothschild & Hartert, 1902, p. 411). In addition it may be repeated (as pointed out by Gifford, *loc cit.*) that the Cocos Island specimens (including one in juvenal plumage) have notably heavy bills as compared with those at hand from the Galapagos, from the Revillagigedo Islands (5) and from the Mexican mainland (1). There is not sufficient material at hand for satisfactory comparison, but there is the suggestion of a distinguishable race upon Cocos Island.

SPECIMENS OF *Nyctanassa violacea pauper* IN THE COLLECTION
OF THE CALIFORNIA ACADEMY OF SCIENCES

Locality	Male adult	Female adult	Male im.	Female im.	Male juv.	Female juv.
Abingdon	1					
Tower	1					
James				1		
Jervis	1	2				
Duncan			1			
Albemarle					3	2
Brattle	2					1
Indefatigable	3		1			2
Seymour						1
Hood	5	1	1			1
Gardner-near-Hood	1					1
Charles					1	

*The word "type" written on the label in Salvin's handwriting. N.B.K.

20. *Phœnicopterus ruber* Linnæus

Phœnicopterus ruber Salvin, 1876, p. 498.—Ridgway, 1890, p. 114 (James and Charles islands); 1897, p. 608 (Charles, James and Indefatigable islands; crit.).—Salvadori, 1895, p. 9 (Galapagos).—Rothschild & Hartert, 1899, p. 182 (Albemarle, Charles and James islands); 1902, p. 411 (eggs).—Snodgrass & Heller, 1904, p. 253 (Albemarle Id.).—Gifford, 1913, p. 66 (plumages, molt, meas., habits, etc.).

Phœnicopterus glyphorhynchus Gray, 1869, p. 442, pl. XIV, fig. 5 (orig. descr.; "Galapagos").

PHENICOPTERUS GLYPHORHYNCHUS Gray

Type.—British Museum, no. 50.1.31.114; ad., sex?; Galapagos; "Pres. by Kellett & Wood."

HABITAT.—Atlantic coast of subtropical and tropical America; in the Pacific, only in the Galapagos Archipelago.

The Academy series from the Galapagos consists of 70 specimens (nos. 2175-2244).

21. *Querquedula discors* (Linnæus)

Querquedula discors Gifford, 1913, p. 79.

HABITAT.—Temperate and tropical America.

The record of this species by Gifford (*loc. cit.*) appears to be the only one from the Galapagos, where, however, it seemed to be of not unusual occurrence. The one specimen collected, an adult male (no. 2336), shows very strongly the white head markings which gave rise to the subspecific name *Querquedula discors albinucha* Kennard (from Louisiana), which fact suggests the inference that the individuals migrating to the Galapagos come from the southeastern portion of the species' breeding range.

22. *Pæcilonitta galapagensis* Ridgway

Pæcilonitta Bahamensis Gould, 1841, p. 135.

Dafila bahamensis Sclater & Salvin, 1870, p. 323 (Indefatigable Id.).

—Salvin, 1876, p. 499; 1883, p. 428 (Charles Id.).

Anas bahamensis Sundevall, 1871, p. 126.

Pæcilonetta bahamensis Gifford, 1913, p. 76 (occurrence, habits, meas., etc.).

Pæcilonetta galapagensis Ridgway, 1890, p. 115 (Charles Id.; orig. descr.); 1897, p. 612 (Albemarle, Duncan, Charles, Hood, Chat-ham, Barrington, Indefatigable, Jarvis and Tower).—Salvadori, 1895, p. 284.

Pæcilonetta bahamensis galapagensis Rothschild & Hartert, 1899, p. 183; 1902, p. 411.—Snodgrass & Heller, 1904, p. 253.
Anas galapagensis Phillips, 1923, p. 351, pl. 41 (monograph).
Pæcilonitta galapagensis Bangs, 1918, p. 87.

PECILONETTA GALAPAGENSIS Ridgway

Type.—United States National Museum, no. 115931; ♂ ad.; Charles Island; April 8 (1888); U. S. Fish Commission, Voyage of Albatross.

HABITAT.—Galapagos Archipelago, where it has been found upon all but Narborough and the outlying northern islands. Specifically reported from Tower, James, Jervis, Duncan, Albemarle, Seymour, Indefatigable, Barrington, Chatham, Hood, and Charles.

The Academy expedition collected 91 specimens (nos. 2245-2335.)

Querquedula versicolor, an Argentine species, has been included in the Galapagos list upon the basis of a specimen recorded by Sundevall (*Anas maculirostris* Sundevall, 1871, p. 126). According to information received by me from Dr. Einar Lönnberg this bird, from the "Eugenie" expedition, is still extant, in the Royal Natural History Museum, Stockholm. It is labelled simply "Galapagos". While it is possible that this duck actually was taken in the archipelago, it seems more likely that this is another case (there are many among early maritime expeditions) where a specimen has been mistakenly attributed to a locality remote from where it was actually obtained. It seems to me an insufficient basis for inclusion of the species in the list of Galapagos birds.

23. *Buteo galapagoensis* (Gould)

Polyborus galapagoensis Gould, 1837, p. 9 ("In insulis Galapagorum").
Craxirex galapagoensis Gould, 1841, p. 23, pl. II.—Sclater & Salvin, 1870, p. 323 (Indefatigable and Abingdon).
Buteo galapagoensis Ridgway, 1890, p. 113; 1897, p. 587.—Rothschild & Hartert, 1899, p. 174; 1902, p. 404.—Snodgrass & Heller, 1904, p. 264.—Swann, 1926, p. 351.
Buteo galapagensis Sundevall, 1871, pp. 125, 127.—Sharpe, 1874, p. 170.—Salvin, 1876, p. 495.—Gifford, 1919, p. 190 (habits).

POLYBORUS GALAPAGOENSIS Gould

Cotype.—British Museum, no. 55.12.19.202; (♂ ad.); "Galapagos Arch."; C. Darwin.

Cotype.—British Museum, no. 55.12.19.203; ♀ juv.; "Galapagos Arch."; C. Darwin.

The two birds are apparently the originals of Gould's description and plate. No. 55.12.19.202 is now labelled as the "type."

Description.—First three primaries deeply emarginate. Sexes alike in color but female appreciably larger than male. *Adult*:

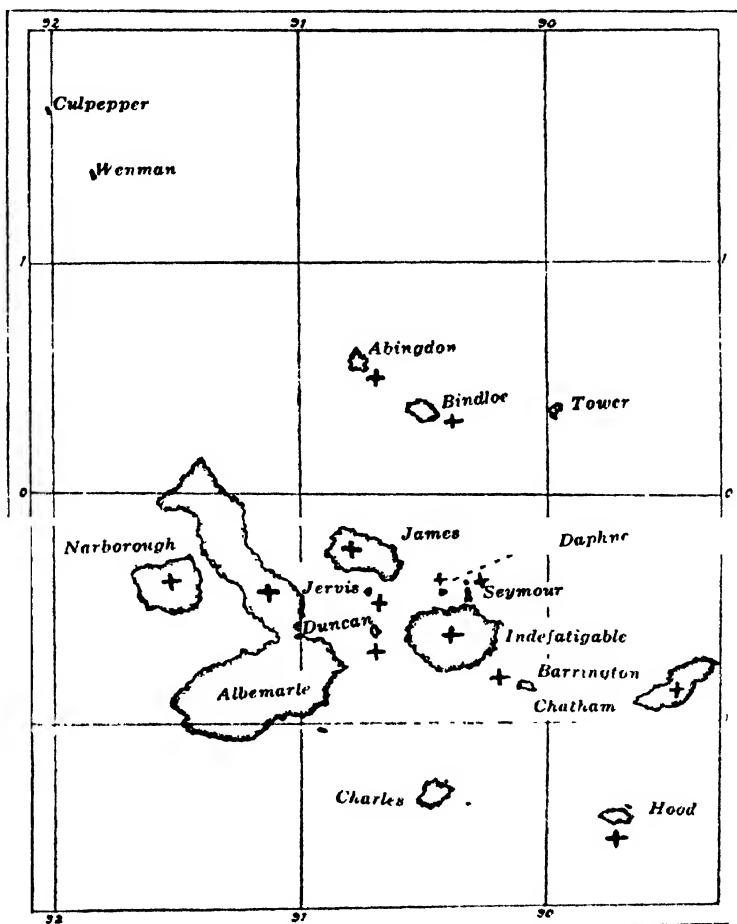


Fig. 1. Map showing distribution of *Buteo galapagoensis*. Symbols indicate islands where recorded.

Nearly uniform sooty brown, darkest (almost black) on head and dorsum, paler on belly and flanks, where the feathers are usually tipped with pale brown and sometimes barred with reddish. Under

tail coverts basally white, and variously barred with white and reddish brown. Flight feathers above blackish brown, darker than coverts; on under surface primaries and secondaries are dusky at the tip, grayish to almost white basally, the inner webs marked with broken bars and frecklings of brown or gray. Upper tail coverts barred (mostly on outer web) with white and dark brown. Tail feathers above sometimes brownish gray, sometimes distinctly hoary, crossed by about nine dusky bars; toward the base bars and ground color merge into a freckling of brownish and hoary gray. Bar at tip of tail broadest, and narrowly margined by a terminal dirty whitish edge. Tail feathers below grayish, with dusky cross bars fairly distinct.

Young (sexes alike): Ground color above sooty brown, broken everywhere by streaks, subbasal spots, or marginal edges to the feathers, of buffy or whitish. Wings about as in the adult, but with more or less buffy or reddish markings on the coverts. Tail feathers hoary gray on central pair and on outer webs of the others, distinctly reddish brown on inner webs, crossed by nine or ten dusky bars, much as in the adult. Tail coverts mostly reddish on exposed portions, whitish elsewhere, and barred with irregular dusky cross markings. Under parts (including sides of head and neck) ochraceous-buff in varying degrees of intensity, with a variable amount of streaks, blotches, and tear shaped spots of dark sooty brown, these largest, sometimes confluent over considerable areas, on flanks and belly. Thighs, under tail coverts and under wing coverts transversely barred with reddish brown.

Nestlings with the above described plumage not entirely acquired have the head and parts of the body clothed with white down. Presumably the natal down is white throughout.

HABITAT.—The Galapagos Archipelago, where reported from the following islands: Bindloe, Abingdon, James, Jervis, Duncan, Albe-marle, Narborough, Indefatigable, Daphne, Seymour, Barrington, Chatham, Hood and Gardner-near-Hood. Gifford (1919, p. 190) definitely states that it was not seen on Charles, Culpepper, Wenman, and Tower.

The Academy series contains 92 specimens (nos. 2803-2894). There is as yet no definite proof as to whether the two types of coloration in this species are or are not indicative of different ages, or if they are individual variations (color phases) that persist unchanged throughout the life time of the individual. Such

evidence as we have tends to show that the streaked plumage pertains to the young, the dark plumage to the fully mature bird, but the evidence is not conclusive.

Nestlings in the collection are in the streaked plumage, none of the dark colored birds show signs of immaturity, dark colored birds have been found with nests (Gifford, 1919. p. 191; also Gifford, MS), and thus far streaked birds have not been found nesting. The Galapagos hawk is very like *Buteo swainsoni* (which has light and dark color phases in the adult stage), and the streaked plumage of *B. galapagoensis* is very similar to the young plumage of *B. swainsoni* (which differs from either adult phase). I am not aware that young *swainsoni* is ever uniformly dark colored. Reasoning from analogy (it is not conclusive). I would infer that the young *Buteo galapagoensis* is always streaked, upon a buffy ground color, and that the fully mature bird is always dark colored throughout. Of most North American hawks the immature plumage is carried through the second summer at least, and I believe that of most species occasional individuals (not many) will be found breeding while still in the immature plumage. Such diverse species as *Buteo platypterus*, *Accipiter cooperi* and *Asturina plagiata* come to mind as within my personal experience. So it is not always an easy matter to decide with hawks as to just what plumages are real color phases and what are representative of different ages, nor is it safe to decide upon a basis of any one sort of evidence. In the case of the Galapagos hawk, Rothschild & Hartert (1899, p. 174) believe that it "occurs in a dark and in a light phase". Ridgway (1897, p. 590) states, "only dark colored adults have hitherto been taken, and *B. galapagoensis* may possibly not have a light colored phase of plumage". The last mentioned is my own belief.

It seems rather curious that a bird of this sort, a powerful flyer, should not be of general distribution throughout the archipelago, but it seems to be definitely absent from certain of the islands. Measurements show the three adult males from Hood Island to be slightly, but appreciably, larger than those from other islands (see table), and while this is a very small number to judge from, of course, it may be said that three streaked males from Hood Island (not included in the table) are of virtually the same size as the dark colored birds from the same place. If these hawks are as sedentary as might be implied from their absence from some

of the islands, it is not surprising that slight variations should appear in parts of their habitat, variations such as the larger measurements of Hood Island specimens seem to be.

Buteo leucops Gray (1848, p. 36) has been generally cited as a synonym of *Buteo galapagoensis*. Sharpe (1874, p. 170) used the type specimen of *leucops* as the basis for his description of the immature plumage of *galapagoensis*. The type of *leucops* is in the British Museum, a well made skin in good condition, and it is not an example of *galapagoensis*. It is a young bird, in fresh plumage, of the wide-spread South American mainland species, *Buteo poliosoma*, whether of true *poliosoma* or var. *pæcilochrous* (if the two really are distinct), I cannot say. It was presented to the British Museum by Burnett and Fitzroy, presumably collected by Captain Fitzroy during the voyage of the "Beagle", of which he was commander. There is little reason to suppose that it was collected upon the Galapagos, and it might have been shot at any one of several South American mainland points at which the "Beagle" touched.* *Buteo leucops* Gray, 1848, is apparently a *nomen nudum*, simply an entry in a list, with one specimen indicated. *Buteo* (*Poecilopternis*) *infulatus* Kaup was based on the same specimen. When I examined this bird I had the benefit of the company of Dr. C. E. Hellmayr, who was working upon South American hawks at the time, and he verified my conclusions regarding the specimen in question.

SPECIMENS OF *Buteo galapagoensis* IN THE COLLECTION
OF THE CALIFORNIA ACADEMY OF SCIENCES

Island	Male (black)	Female (black)	Male (streaked)	Female (streaked)
Bindloe		1		1
Abingdon				1
Jervis	1	1		
Duncan	3	2		1
Indefatigable	9	9	28	18
Seymour	2	1		
Barrington	4	1	2	
Chatham			1	
Hood	3		3	

*This specimen I think without doubt is no. 37.2.21.232 of Burnett and Fitzroy, and came from Port Desire. N.B.K.

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM) OF ADULT (BLACK)
SPECIMENS OF *Buteo galapagoensis*

Number of Specimens	Island	MALE					Middle toe without claw
		Wing	Tail	Culmen (from cere)	Tarsus		
1	Jervis	385.0	200.0	27.5	79.0		44.0
3	Duncan	386.3 (377.0-395.0)	199.7 (191.0-210.0)	27.3 (27.0-28.0)	73.7 (72.0-75.0)		44.0 (42.0-46.0)
11	Indefatigable	379.5 (365.0-393.0)	207.1 (205.0-215.0)	26.9 (26.0-28.0)	72.4 (70.0-76.0)		42.9 (41.0-44.0)
4	Barrington	389.7 (385.0-395.0)	209.5 (207.0-212.0)	27.4 (27.0-27.5)	75.5 (75.0-76.0)		43.5 (42.0-44.0)
3	Hood	420.0 (410.0-432.0)	223.0 (217.0-235.0)	30.0 (28.5-32.5)	80.3 (74.0-85.0)		49.3 (46.0-56.0)
FEMALE							
1	Bindloe	435.0	243.0	30.0	80.0		47.0
1	Jervis	420.0	225.0	31.0	81.0		50.0
2	Duncan	412.0-415.0	222.0-223.0	31.5-32.0	81.0-82.0		48.0-48.0
10	Indefatigable	419.7 (410.0-433.0)	231.9 (225.0-237.0)	30.9 (30.0-32.0)	81.1 (74.0-89.0)		47.6 (44.0-53.0)
1	Barrington	435.0	233.0	32.0	84.0		50.0

24. *Pandion haliaëtus carolinensis* (Gmelin)

Pandion haliaëtus Gifford, 1919, p. 193.

Apparently first reported from the Galapagos Islands by the Academy expedition. As recorded by Gifford (*loc. cit.*), the species was seen about Cocos Island in September, and on Albe-marle and Chatham islands during August, November and February. Two specimens were collected, both adult males, one on Cocos Island, September 7, 1905 (no. 2908), and one on South Albe-marle, November 2, 1905 (no. 2907). These birds are almost purely white below, with only a few flecks of brownish on the upper breast. They are indistinguishable from Lower Californian specimens at hand, and are presumably of the North American form. Chapman (1926, p. 243) speaks of *carolinensis* as "known in Ecuador only as a winter visitant," which may be taken as the manner of its occurrence upon the Galapagos.

25. *Creciscus spilonotus* (Gould)

Zapornia spilonota Gould, 1841, p. 132, pl. 49 ("Galapagos Archipelago"; orig. descr.).

Ortygometra spilonota Gray, 1844, p. 119.

Porzana spilonota Sclater & Salvin, 1870, p. 323 (Indefatigable).—Salvin, 1876, p. 500.—Ridgway, 1897, p. 618.—Snodgrass & Heller, 1904, p. 256.

Creciscus spilonotus Sharpe, 1894, p. 137.—Rothschild & Hartert, 1899, p. 184.—Gifford, 1913, p. 12 (distribution, life history, etc.).

Porzana galapagoensis Sharpe, 1894, p. 113 (orig. descr.; no type or exact type locality designated).—Ridgway, 1897, p. 619.

Creciscus sharpei Rothschild & Hartert, 1899, p. 185 (orig. descr.; Indefatigable Island); 1902, p. 412.—Hartert, 1927, p. 24 (particulars of type specimen, in Tring Museum).

Porzana sharpei Snodgrass & Heller, 1904, p. 256 (Narborough).

ZAPORNIA SPILONOTA Gould

PORZANA GALAPAGOENSIS Sharpe

Cotype.—British Museum; juv., sex?; (Galapagos). This is specimen "a" of Catalogue of Birds, vol. XXIII, p. 113, apparently never entered in any Museum register, as it has no catalogue number. It bears two red "type labels" (!), one for *Zapornia spilonota* Gould, one for *Porzana galapagoensis* Sharpe, both attached at a relatively recent date.

Cotype.—British Museum, no. 180a; juv., sex?; Galapagos;

"ex coll. Burnett & Fitzroy." Specimen "b" of Catalogue of Birds, *loc cit.*

Cotype.—British Museum; ad., sex?; Galapagos. Specimen "e" of Catalogue of Birds, vol. XXIII, p. 137.

CRECISCUS SHARPEI Rothschild & Hartert

Type.—Rothschild Museum; ♂ ad.; Indefatigable Island; September 2, 1897; C. D. Hull (Webster-Harris expedition); orig. no. 942.

DESCRIPTION.—Sexes essentially alike. Length 145 to 160 mm., spread wings 228 to 245 (collector's measurements of dead birds). Adult: Head, neck and lower parts dark slate (from neutral gray to deep neutral gray), deepening to blackish on lower flanks and abdomen. Dorsum clear brownish (close to chestnut-brown), abruptly defined against gray of neck; outer surface of wings duller and paler brown; lower back, rump and tail feathers becoming blackish. Flank feathers with paired white spots or narrow bars; wing coverts, tertials, and lower back usually with more or less white spotting. In a few cases the white spots are entirely absent, and when present vary in amount from a few inconspicuous flecks, to a larger number, sharply defined and with margins of blackish. White spots may be present on the wings and not on the back, but in no case are they present on the back and not on the wings. "Bill blackish, feet and legs brownish, iris reddish" (R. H. Beck, MS). Juvenal: Top of head and lower parts generally sooty brown, darkest on pileum and sides, slightly grayish on face and throat. Back of neck and upper back slightly paler brown, lower back, rump, tail (with upper and lower coverts), sooty blackish. Outer surface of wings dark brownish, almost black. No white spots on wing, flanks or belly. (From specimen in the British Museum.)

HABITAT.—The Galapagos Islands, where reported from Abingdon, James, Seymour, Indefatigable, Albemarle and Narborough.

The Academy expedition collected 79 specimens (nos. 257-335).

Zapornia spilonota was described and figured by Gould in the account of the birds collected on the voyage of the "Beagle" (1841, p. 132, pl. 49). No type specimen was indicated, but Darwin's statement that his specimens were collected upon James Island suffices to fix a type locality. Three of those specimens eventually went to the British Museum, where they now are. Sharpe (1894)

regarded these as representing two genera and species, *Creciscus spilonotus* (p. 137) from James and Indefatigable, and *Porzana galapagoensis* (p. 113), "exact island not indicated". Rothschild & Hartert (1899, pp. 184-185), similarly convinced that two species of rails occur in the Galapagos, named *Creciscus sharpei* (from

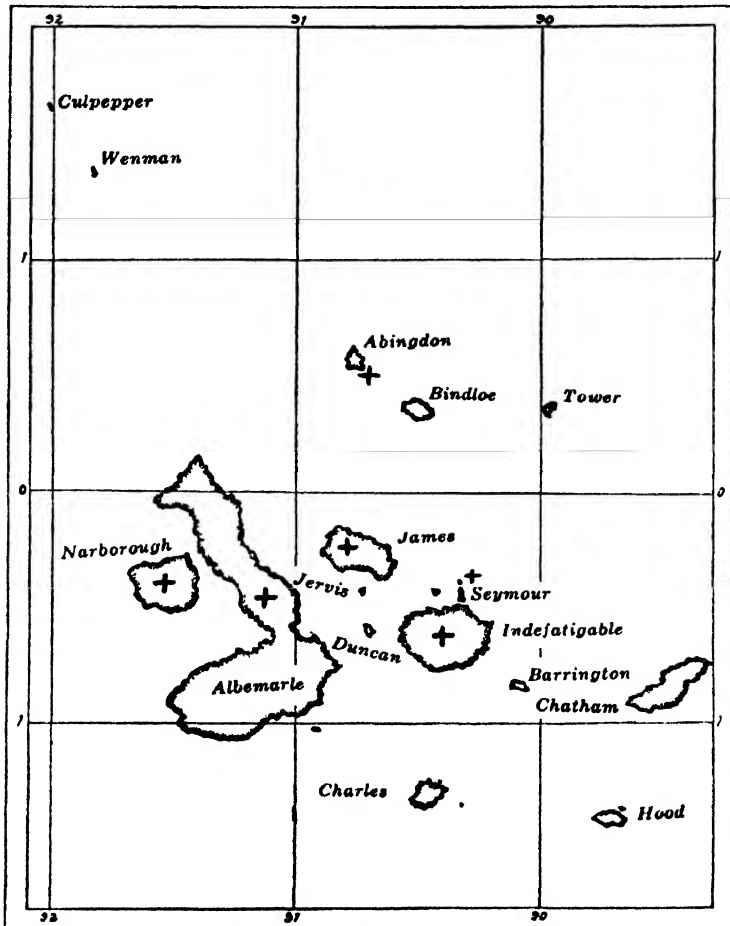


Fig. 2. Map showing distribution of *Creciscus spilonotus*. Symbols indicate islands where recorded.

Indefatigable Island), regarding *Porzana galapagoensis* as a synonym of *Creciscus spilonotus* (Gould). Up to that time Darwin's three skins assumed to be from James Island were the only ones to be collected upon that island.

The Academy expedition brought back twelve specimens from James Island, and in our own and other collections I have been able to examine other series from Abingdon, Indefatigable and Albemarle. They are all the same; I can see no grounds for recognition even of subspecies from the different islands. Two of the three "Beagle" specimens in the British Museum are juveniles, one entirely in juvenal plumage, the other acquiring some adult gray feathers on the breast. These are the two birds that Sharpe described as *Porzana galapagoensis*. The third, an ordinary adult, he listed as the young of *Creciscus spilonotus*.

Sharpe (*loc. cit.*, p. 138) says: "The type specimen [of *Zapornia spilonota*] seems not to have been transferred with the rest of the Zoological Society's Collection," a statement that Rothschild & Hartert (1899, p. 185) question, in the belief that the several skins now in the British Museum were the entire type series. However, not one of these three skins accords with Gould's description and colored plate, in that none has the white spots on the wing, and only one the spots on the flanks that are there so carefully featured. So that the type series may very well have included one or more additional adults that were subsequently lost.

SPECIMENS OF *Creciscus spilonotus* IN THE ACADEMY COLLECTION

Island	Male	Female	Sex undetermined
Abingdon	1	2	
James	4	8	
Seymour	1		
Indefatigable	33	28	2

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM)
OF *Creciscus spilonotus*

		MALES				
Number of specimens	Island	Wing	Tail	Culmen	Tarsus	Middle toe with claw
1	Abingdon	67.0	26.2	16.0	22.2	28.5
4	James	67.5 (66.0-69.0)	26.4 (25.0-27.0)	15.4 (15.0-16.2) ¹	23.4 (23.0-24.0)	29.8 (29.5-30.2)
10	Indefatigable	66.6 (64.0-72.5)	24.0 (22.0-26.2)	15.8 (15.0-17.0)	22.6 (21.5-23.5)	28.8 (27.5-29.0)
1 ¹	Albemarle	69.0	23.5	14.5	22.5	31.0
FEMALES						
2	Abingdon	65.5-66.0	24.0-24.0	14.5-14.5	21.0-21.0	27.5-28.0
8	James	66.6 (65.0-68.5)	25.1 (23.5-27.0)	15.7 (14.5-16.2)	22.7 (22.0-23.5) [*]	28.9 (28.0-29.5)
10	Indefatigable	66.1 (61.0-70.5)	23.2 (20.0-25.0)	14.5 (13.5-15.5)	21.6 (20.0-23.0)	27.9 (26.5-29.5)
1 ¹	Albemarle	68.5	26.0	14.8		30.5

¹ Three specimens

² Rothschild Collection

³ Seven specimens

SPECIMENS OF *Creciscus spilonotus* IN THE BRITISH MUSEUM COLLECTED ON THE
VOYAGE OF THE "BEAGLE"

No.	Sex	Age	Locality	Wing	Tail	Culmen	Tarsus	Middle toe with claw
180a	?	juv.	?	66.2	25.0	16.0	25.0	29.2
	?	juv.	"Galapagos"	73.0	25.0	16.8	24.0	30.5
	?	ad.	"Galapagos"	68.5	23.5	16.2	24.0	30.5

Specimen "a", Cat. Birds, vol. 23, p. 113
Specimen "b", Cat. Birds, vol. 23, p. 113
Specimen "c", Cat. Birds, vol. 23, p. 137

26. *Gallinula chloropus cachinnans* Bangs

Gallinula galeata Ridgway, 1897, p. 621 (Albemarle Id.).—Rothschild & Hartert, 1899, p. 186 (Albemarle Id.); 1902, p. 412.—Snodgrass & Heller, 1904, p. 257 (Albemarle Id.).—Gifford, 1913, p. 16 (Albemarle and Chatham islands).

Gallinula chloropus cachinnans Bangs, 1915, p. 96.

HABITAT.—Parts of temperate North America, Central America, West Indies, and Galapagos Archipelago. In the Galapagos Archipelago reported thus far only from Albemarle and Chatham islands, where it is not uncommon.

The Academy expedition collected two male birds (nos. 336, 337) (see Gifford, *loc. cit.*). These, compared with North American skins, are noticeably lacking in any olivaceous tinge to the upper parts, just as Ridgway (*loc. cit.*) describes the three Galapagos specimens that he examined, but in two others at hand from the Stanford University collection (see Snodgrass & Heller, *loc. cit.*), the upper parts are conspicuously olive brown, in one of them to as extreme a degree as in any North American bird that I have seen. There is thus no feature common to these four birds whereby they can be distinguished from California-taken specimens, of which there are fifteen comparable adults available.

27. *Hæmatopus palliatus galapagensis* Ridgway

Hæmatopus palliatus Sclater & Salvin, 1870, p. 323 (Indefatigable Id.).—Sundevall, 1871, p. 125.—Salvin, 1876, p. 502.

Hæmatopus galapagensis Ridgway, 1886, p. 331 (Chatham Id.; orig. descr.); 1887, p. 325; 1890, p. 116 (James Id.); 1897, p. 621 (Albemarle, Hood, Chatham, Indefatigable, James, and Bindloe islands).—Sharpe, 1896, p. 116.—Rothschild & Hartert, 1899, p. 186; 1902, p. 412.—Snodgrass & Heller, 1904, p. 262.—Gifford, 1913, p. 47.

Hæmatopus palliatus galapagensis Ridgway, 1919, p. 39.—Murphy, 1925, p. 9 (characters and relationships).

HÆMATOPUS GALAPAGENSIS Ridgway

Type.—United States National Museum, no. 101319; ad., sex?; Chatham Island; August 16, 1884; Dr. Wm. H. Jones; orig. no. 64.

HABITAT.—Apparently throughout the greater part of the Galapagos Archipelago, though not reported thus far from the outlying northern islands, Culpepper and Wenman.

The Academy expedition collected 44 specimens (nos. 1887-1930).

The differences between *Hæmatopus p. galapagensis* and *H. p. frazari* (of Lower California) are slight. The Galapagos bird is darker colored dorsally and it has a heavier foot (an average character). The resemblances here are of note, considering how meager are the indications in the Galapagos avifauna of affinities toward the west coast of North America. Murphy (1925, pp. 6, 11) points out that the Atlantic form of the Oystercatcher (*palliatu*s) crosses to the Pacific side in the Panama region, as indicated by the white-marked primaries of birds from that section, and considering the strong West Indian complexion borne by the aquatic avifauna of the Galapagos it might well have been predicted that the Oystercatcher, too, would be of the Atlantic strain. The fact remains that in the Galapagos birds the primaries bear no white marks along the quills, and that they are closely similar to the Lower California form.

28. *Squatarola squatarola* (Linnæus)

Squatarola squatarola Ridgway, 1897, p. 626 (Albemarle Id., August); 1919, p. 72.—Rothschild & Hartert, 1899, p. 187 (Charles Id., November).—Snodgrass & Heller, 1904, p. 261 (Albemarle Id., February).

Squatarola helvetica Gifford, 1913, p. 53 (Albemarle, Charles, Chatham, Hood, Indefatigable, and James islands).

HABITAT.—Cosmopolitan; a transient visitor to the Galapagos.

The Academy expedition collected one specimen, upon Albemarle Island, March 7, 1906 (no. 1959).

29. *Charadrius semipalmatus* Bonaparte

Hiaticula semipalmata Gould, 1841, p. 128 (Galapagos Archipelago). *Ægialitis semipalmata* Sclater & Salvin, 1870, p. 323 (Indefatigable Id.).—Salvin, 1876, p. 501.—Ridgway, 1897, p. 628 (Albemarle Id.).—Rothschild & Hartert, 1899, p. 186 (Chatham, Charles, Albemarle, Jervis, and Indefatigable islands, July 29 to Dec. 3).—Snodgrass & Heller, 1904, p. 261 (Albemarle and Narborough islands).

Ægialeus semipalmatus Sharpe, 1896, p. 250.—Gifford, 1913, p. 53 (Abingdon, Albemarle, Bindloe, Charles, Chatham, Indefatigable, James, Jervis, and Narborough islands, July 17 to April 25).

Charadrius semipalmatus Ridgway, 1919, p. 116.

HABITAT.—Breeds in Arctic and sub-arctic North America, migrating to southern South America in winter. Apparently a fairly common winter visitant to the Galapagos Archipelago.

The Academy expedition collected seven specimens in the Galapagos and three upon Cocos Island (nos. 1963-1972).

30. *Arenaria interpres interpres* (Linnaeus)

Strepsilas interpres Gould, 1841, p. 132 ("Galapagos Archipelago").—Sclater & Salvin, 1870, p. 323 (Indefatigable and Bindloe islands).—Salvin, 1876, p. 502.

Arenaria interpres Ridgway, 1890, p. 116 (Hood Id.); 1897, p. 625.

—Sharpe, 1896, p. 92.—Rothschild & Hartert, 1899, p. 187.—Snodgrass & Heller, 1904, p. 261.—Gifford, 1913, p. 46.

Arenaria interpres interpres Ridgway, 1919, p. 45.

HABITAT.—Breeds in the Arctic regions. Occurs in the Galapagos Archipelago as an abundant visitant, numerous during fall, winter and spring; occasional non-breeding individuals are seen during the summer.

The Academy expedition collected 31 specimens, including two from Cocos Island (nos. 1853-1883.)

31. *Pisobia bairdii* (Coues)

Heteropygiu bairdi Rothschild & Hartert, 1899, p. 188 (Barrington Id., October 6, 1897, one bird).—Gifford, 1913, p. 57.

Tringa bairdii Snodgrass & Heller, 1904, p. 258.

Pisobia bairdi Ridgway, 1919, p. 279.

HABITAT.—The arctic coast of North America in summer; southward into South America in winter.

Occurrence in the Galapagos Archipelago is known only through the record by Rothschild & Hartert (*loc. cit.*).

32. *Pisobia minutilla* (Vieillot)

Pelidna minutilla Gould, 1841, p. 131 ("Galapagos Archipelago").

Tringa minutilla Sclater & Salvin, 1870, p. 323 (Indefatigable Id.).

—Salvin, 1876, p. 504.—Ridgway, 1897, p. 631.—Rothschild & Hartert, 1899, p. 188 (Charles and Barrington islands).—Snodgrass & Heller, 1904, p. 258.

Limonites minutilla Sharpe, 1896, p. 548.—Gifford, 1913, p. 56 (Abingdon, Albemarle, Barrington, Charles, Indefatigable and James islands).

Pisobia minutilla Ridgway, 1919, p. 294.

HABITAT.—Arctic North America in summer; southward into South America in winter.

Apparently a not uncommon visitant to the Galapagos Archi-

pelago. The Academy expedition collected three specimens, on Charles, Abingdon and Albemarle island, respectively (nos. 1998, 1999, 2003).

33. *Crocethia alba* (Pallas)

Calidris arenaria Selater & Salvin, 1870, p. 323 (Bindloe Id.).—Salvin, 1876, p. 503.—Ridgway, 1897, p. 629 (Albemarle and Bindloe islands).—Rothschild & Hartert, 1899, p. 187 (Albemarle, Chatham, Hood, Abingdon, Jervis and Bindloe islands).—Gifford, 1913, p. 56 (nine islands).

Calidris alba Ridgway, 1919, p. 308.

HABITAT.—Circumpolar, breeding only in the far north. Southward over most of the world in migrations and in winter, when it occurs commonly on the Galapagos Islands.

Three specimens were collected by the Academy expedition (nos. 1994-1996).

34. *Tringa solitaria* Wilson

Helodromas solitarius Rothschild & Hartert, 1899, p. 188 (Chatham Id., October 12, 1897, two specimens).—Snodgrass & Heller, 1904, p. 259.—Gifford, 1913, p. 55.

Tringa solitaria cinamomea Ridgway, 1919, p. 363.

HABITAT.—Northern North America in summer, southward into South America in winter.

Occurrence in the Galapagos Archipelago is known only through the record by Rothschild & Hartert (*loc. cit.*).

35. *Catoptrophorus semipalmatus inornatus* (Brewster)

Symphemia semipalmata Gifford, 1913, p. 55.

Catoptrophorus semipalmatus inornatus Ridgway, 1919, p. 319.

HABITAT.—North America in summer, southward into South America in winter.

Birds seen or collected by the Academy expedition on Abingdon and Albemarle islands afford apparently the only records of occurrence upon the Galapagos (Gifford, *loc. cit.*). The one specimen collected (no. 1980), in winter plumage, accords in its measurements with Ridgway's (*loc. cit.*) diagnosis of the subspecies *inornatus*.

36. *Heteroscelus incanus* (Gmelin)

Totanus fuliginosus Gould, 1841, p. 130 ("Galapagos Archipelago").
Totanus brevipes Sclater & Salvin, 1870, p. 323 (Indefatigable and Abingdon islands).

Heteroscelus incanus Salvin, 1876, p. 503.—Ridgway, 1919, p. 367.
Heteractitis incanus Ridgway, 1890, p. 116; 1897, p. 632.—Sharpe, 1896, p. 453.—Rothschild & Hartert, 1899, p. 188.—Snodgrass & Heller, 1902, p. 511 (Cocos Id.); 1904, p. 259.—Gifford, 1913, p. 55.

TOTANUS FULIGINOSUS Gould

Type.—British Museum, no. 37.2.21.263; [♀]; "Galapagos"; date?; received from Burnett and Fitzroy.

Heteroscelus incanus in winter plumage.

HABITAT.—Breeds in Alaska. In winter southward along Pacific coasts of America and Asia to the south Pacific islands and to the Galapagos.

The Academy expedition collected nine specimens, including one from Cocos Island and one from Clipperton Island (nos. 1981-1989).

37. *Actitis macularia* (Linnaeus)

Actitis macularia Snodgrass & Heller, 1904, p. 260 (Albemarle Id., January).—Ridgway, 1919, p. 372.

Tringoides macularius Gifford, 1913, p. 56 (Abingdon and Albemarle islands).

HABITAT.—North America in summer, southward into South America in winter.

Occurrence of this species in the Galapagos Archipelago is known only from the observations of Snodgrass & Heller (*loc. cit.*), and of Gifford (*loc. cit.*).

38. *Numenius hudsonicus* Latham

Numenius hudsonicus Sclater & Salvin, 1870, p. 323 (Indefatigable).

—Salvin, 1876, p. 504.—Sharpe, 1896, p. 364.—Ridgway, 1897, p. 633.—Rothschild & Hartert, 1899, p. 189.—Snodgrass & Heller, 1904, p. 260.—Gifford, 1913, p. 54.

Phæopus hudsonicus Ridgway, 1919, p. 402.

Numenius borealis Salvin, 1883, p. 429 (see Rothschild & Hartert, 1899, p. 189).

HABITAT.—Breeds in boreal America. Occurs in the Galapagos Archipelago as a common winter visitant.

The Academy expedition collected four specimens, three on Albemarle, one on Cocos Island (nos. 1976-1979).

39. *Himantopus mexicanus* (Müller)

Himantopus nigricollis Sclater & Salvin, 1870, p. 323 (Indefatigable Id.).—Salvin, 1876, p. 502.

Himantopus mexicanus Ridgway, 1890, p. 116 (James Id.); 1919, p. 442.—Sharpe, 1896, p. 321.—Rothschild & Hartert, 1899, p. 189 (Indefatigable, Albemarle, and Chatham islands); 1902, p. 412.—Snodgrass & Heller, 1904, p. 258 (Albemarle, James, Seymour and Hood islands).—Gifford, 1913, p. 54, pl. 1, fig. 2.

? *Himantopus mexicanus* Ridgway, 1897, p. 633.

HABITAT.—Southern North America and northern South America.

Presumably resident in the Galapagos Archipelago, where it has been reported from the following islands: James, Albemarle, Narborough, Indefatigable, Seymour, Chatham, Hood, and Charles. The Academy expedition collected two adult males and one adult female, all on Albemarle (nos. 1973-1975).

The Black-necked Stilt appears here to afford an example of an island form in an early stage of differentiation from the ancestral mainland stock. Our few specimens were so obviously short-legged as compared with California birds as to impel me to measure other Galapagos skins when opportunity offered. These were not many, but so far as they go they also exhibit the character of a short tarsus (see table). The slight overlapping in tarsal measurements shown in the males, as between the Galapagos and California series, is afforded by just one peculiarly short-legged California specimen, found after search through more skins than are included in this table. There is apparently a shortening of the tibia of Galapagos birds also, but this proved impossible to measure accurately. Further comparisons should be made with South American mainland specimens, which I have not been able to do.

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM) OF
Himantopus mexicanus

Number of specimens	Locality	Wing	Tail	Culmen	Tarsus	Middle toe with claw
10 males	California	224.7 (218.0-235.0)	70.5 (68.0-73.0)	64.5 (60.0-67.5)	115.7 (105.0-120.0)	42.6 (40.0-45.0)
8 males	Galapagos	214.2 (185.0-228.0)	71.1 (69.0-73.0)	62.9 (60.0-65.0)	100.8 (93.5-109.0)	41.8 (39.0-44.0)
10 females	California	212.8 (204.0-220.0) ¹	70.0 (63.0-73.5)	62.8 (58.2-69.0)	104.5 (99.0-116.0)	40.5 (39.0-43.0)
4 females	Galapagos	191.1 (184.0-200.0)	65.6 (60.0-68.0)	60.2 (60.0-60.5) ²	89.2 (84.0- 93.0)	39.8 (38.0-40.8)

¹ Six specimens

² Two specimens

40. *Lobipes lobatus* (Linnæus)

Phalaropus lobatus Snodgrass & Heller, 1904, p. 257 ("off the south-east point of Narbboro", March 29).

Phalaropus hyperboreus Gifford, 1913, p. 57.

Lobipes lobatus Ridgway, 1919, p. 424.

HABITAT.—Circumpolar, breeding in the far north of both hemispheres; in winter south of the equator.

According to Gifford (*loc. cit.*) an abundant visitant to the Galapagos Archipelago.

41. *Steganopus tricolor* Vieillot

Steganopus tricolor Gifford, 1913, p. 57 (Albemarle Id., November 3, 1905).—Ridgway, 1919, p. 431.

HABITAT.—Parts of temperate North America; south in winter to extreme southern South America.

Known to occur in the Galapagos Archipelago only as reported by Gifford (*loc. cit.*), who records capture of three specimens (nos. 2010-2012) by the Academy expedition.

42. *Stercorarius pomarinus* (Temminck)

Stercorarius pomarinus Rothschild & Hartert, 1899, p. 192 (Albemarle Id., December 15, 1897, one specimen).—Snodgrass & Heller, 1904, p. 236.

Stercorarius pomatorhinus Gifford, 1913, p. 46.

Coprotheres pomarinus Ridgway, 1919, p. 681.

HABITAT.—Circumpolar, breeding in the far north of both hemispheres. In winter southward to points below the equator.

Known from the Galapagos Archipelago apparently only from one record, by Rothschild & Hartert (*loc. cit.*).

43. *Larus fuliginosus* Gould

Larus fuliginosus Gould, 1841, p. 141 (James Id.; orig. descr.).—Sclater & Salvin, 1870, p. 323 (Indefatigable and Abingdon islands).—Sundevall, 1871, p. 125 (Charles and Indefatigable islands).—Salvin, 1876, p. 505, pl. 87.—Saunders, 1878, p. 184 (monograph); 1896, p. 222.—Ridgway, 1890, p. 116 (Indefatigable, James and Chatham islands); 1897, p. 635.—Rothschild & Hartert, 1899, p. 189; 1902, p. 413.—Snodgrass & Heller, 1904, p. 237.—Gifford, 1913, p. 42.

Blasipus fuliginosus Ridgway, 1919, p. 656 (descr., adult and young, meas., etc.).

LARUS FULIGINOSUS Gould

Cotype.—British Museum (no catalogue number); ad., sex?; Galapagos Archipelago; Sir. W. Burnett and Captain Fitzroy. (Apparently specimen "a" of the Catalogue of Birds, vol. 25, p. 222.)

Cotype.—British Museum [55.12.19.218]; ad., sex?; Galapagos; C. Darwin. (Apparently specimen "b" of the Catalogue of Birds, *loc. cit.*)

While there is no exact locality upon the labels of these specimens, Darwin (*in* Gould, 1841, p. 141) says: "My specimen was killed at James Island".

HABITAT.—Galapagos Archipelago.

The Academy expedition collected 107 specimens (nos. 1735-1841).

44. **Larus pipixcan** Wagler

Larus franklinii Snodgrass & Heller, 1904, p. 237 (Narborough, March, one specimen).

Larus franklini Gifford, 1913, p. 42 (Chatham, February 10; Albe-marle, March 6).

Chroicocephalus franklinii Ridgway, 1919, p. 641.

HABITAT.—North-central North America in summer, south as far as the west coast of South America in winter.

First reported from the Galapagos Archipelago by Snodgrass & Heller (*loc. cit.*). The Academy expedition collected two specimens (nos. 1733, 1734), comprising the sum total of additional records up to the present time.

45. **Creagrus furcatus** (Neboux) *

Creagrus furcatus Salvin, 1876, p. 506 (the second known specimen, from Dalrymple Rock, Chatham Id.).—Ridgway, 1890, p. 117 (Chatham Id; *crit.*); 1897, p. 638; 1919, p. 659.—Snodgrass & Heller, 1904, p. 237.—Gifford, 1913, p. 35.

Xema furcata Saunders, 1896, p. 165.—Rothschild & Hartert, 1899, p. 190; 1902, p. 412.

Xema furcatum Saunders, 1878, p. 210 (monograph); Streets, 1912, p. 233 (actions and appearance).

**Larus furcatus* Neboux (1840, p. 290) was ascribed to "Monterey" (California), on the basis of a specimen collected during the voyage of the "Venus." The vessel touched at the Galapagos and there is reason to believe that this gull may have been collected there rather than at Monterey. (See Grinnell, Pac. Coast Avifauna, no. 11, 1915, p. 175.)

HABITAT.—The Galapagos Archipelago. One or two stragglers have been found on the adjacent coast of South America and Panama.

The Academy expedition collected 108 specimens (nos. 1625-1732).

46. *Sterna fuscata crissalis* (Lawrence)

Sterna fuliginosa Rothschild & Hartert, 1899, p. 191 (Culpepper and Wenman islands); 1902, p. 413.—Snodgrass & Heller, 1904, p. 239.—Gifford, 1913, p. 19 (Culpepper, Wenman, and Crossman islands).

Sterna fuscata crissalis Ridgway, 1919, p. 519.

HABITAT.—Pacific coast of Mexico and Central America, southward to the Galapagos Archipelago.

47. *Anous stolidus galapagensis* Sharpe

Megaloptyx stolidus Gould, 1841, p. 145, part ("Galapagos Archipelago").

Anous stolidus Sundevall, 1871, p. 125.—Salvin, 1876, p. 504.—Ridgway, 1890, p. 116 (Chatham Id.).—Gifford, 1913, p. 24.

Anous galapagensis Sharpe, 1879, p. 469 (Dalrymple Rock, Chatham Id.; orig. descr.).—Salvin, 1883, p. 430 (Charles Id.).—Stone, 1894, p. 117.—Saunders, 1896, p. 143.—Ridgway, 1897, p. 642.

Anous stolidus galapagensis Rothschild & Hartert, 1899, p. 191; 1902, p. 413.—Snodgrass & Heller, 1904, p. 239.—Ridgway, 1919, p. 551.

ANOUS GALAPAGENSIS Sharpe

Type.—British Museum, no. 50.1.31.14: im., sex?; Dalrymple Rock, Chatham Island; no date; received from Kellett and Wood.

A poorly made skin with one wing missing.

HABITAT.—The Galapagos Archipelago.

The Academy expedition collected 85 specimens (nos. 1426-1510).

48. *Gygis alba* (Sparrman)

Gygis alba Gifford, 1913, p. 32.

Gygis alba candida ? Ridgway, 1919, p. 559.

HABITAT.—Intertropical portions of Pacific, Indian, and southern Atlantic oceans.

The statement by Gifford (*loc. cit.*) of one seen off Tower Island,

September 14, 1906, appears to be the only record for the Galapagos Archipelago.

Genus NESOPELIA Sundevall

Nesopelia Sundevall, Met. Nat. Avium Disp. Tent., ii, 1873, 99. Type *Zenaida galapagoensis* Gould. (For generic characters and for detailed descriptions of subspecies see Ridgway, Birds of North and Middle America, VII, 1916, pp. 372-376.)

49. *Nesopelia galapagoensis galapagoensis* (Gould)

Zenaida galapagoensis Gould, 1841, p. 115, pl. 46 (orig. descr.; "Galapagos Archipelago").—Sclater & Salvin, 1870, p. 323 (Indefatigable and Bindloe islands).—Ridgway, 1890, p. 116.

Zenaida galapagensis Salvin, 1876, p. 499.

Columba galapagensis Sundevall, 1871, p. 125 (James Id.).

Nesopelia gallopagoensis Sundevall, 1873, p. 99. [Not seen by me. H.S.S.]

Nesopelia galapagoensis Salvadori, 1893, p. 390.—Ridgway, 1897, p. 614.—Gifford, 1913, p. 6, part.

Nesopelia galapagoensis galapagoensis Rothschild & Hartert, 1899, p. 183; 1902, p. 411.—Snodgrass & Heller, 1904, p. 262.—Ridgway, 1916, p. 373.

ZENAIIDA GALAPAGOENSIS Gould

Cotype.—British Museum, no. 81.2.18.84; (♀?); "Galapagos"; no date; C. Darwin.*

This is a small, dull colored bird, apparently a female. Gould's plate appears to be made from a male, which may have been mounted and later destroyed. The skin in the British Museum may be assumed to be one of several specimens upon which the species was based.

HABITAT.—The Galapagos Archipelago, where recorded from all the principal islands except Culpepper and Wenman (occupied by another subspecies).

50. *Nesopelia galapagoensis exsul* Rothschild & Hartert

Nesopelia galapagoensis exsul Rothschild & Hartert, 1899, p. 184 (Culpepper and Wenman islands; orig. descr.).—Snodgrass & Heller, 1904, p. 263.—Ridgway, 1916, p. 375.—Hartert, 1927, p. 9 (particulars of type specimen, in Rothschild Museum).

Nesopelia galapagoensis Gifford, 1913, p. 6, part (Culpepper and Wenman islands).

NESOPELIA GALAPAGOENSIS EXSUL Rothschild & Hartert

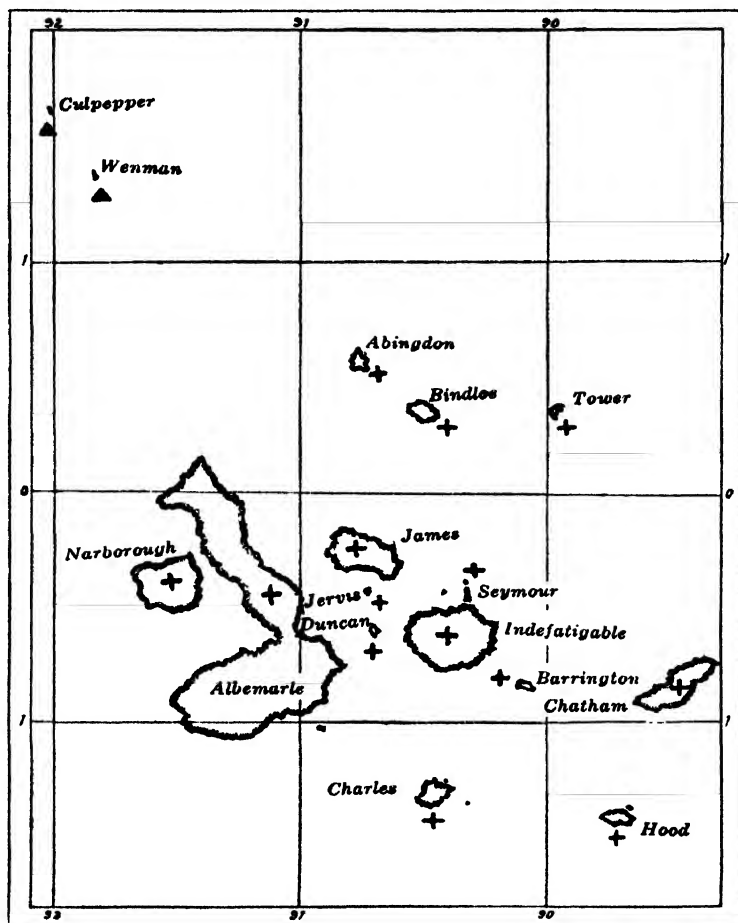
Type.—Rothschild Museum; ♂ ad.; Culpepper Island; July 27.

*Ex Eyton collection and Zoological Society collection. N.B.K.

1897; F. P. Drowne (Webster-Harris expedition); orig. no. 180.

HABITAT.—Culpepper and Wenman islands, Galapagos Archipelago.

The Academy expedition collected 226 specimens of this species (including *galapagoensis* 206, *exsul* 20), catalogued, mixed together, under the inclusive numbers 31-256.



▲ *Nesopelia galapagoensis exsul*

+ *Nesopelia galapagoensis galapagoensis*

Fig. 3. Map showing distribution of subspecies of *Nesopelia galapagoensis*. Symbols indicate islands where recorded.

SPECIMENS OF *Nesopelia galapagoensis* IN THE COLLECTION
OF THE CALIFORNIA ACADEMY OF SCIENCES

	Island	Adult male	Adult female	Young male	Young female	Sex undetermined
<i>Nesopelia g. exsul</i>	Culpepper	3	1			
<i>Nesopelia g. exsul</i>	Wenman	10	4	2		
<i>Nesopelia g. galapagoensis</i>	Abingdon	2	5	1	1	1
<i>Nesopelia g. galapagoensis</i>	Bindloe		1			
<i>Nesopelia g. galapagoensis</i>	Tower		1			
<i>Nesopelia g. galapagoensis</i>	James		4			
<i>Nesopelia g. galapagoensis</i>	Jervis	4	11			1
<i>Nesopelia g. galapagoensis</i>	Narborough	1				
<i>Nesopelia g. galapagoensis</i>	Duncan	33	8			
<i>Nesopelia g. galapagoensis</i>	Seymour		7			
<i>Nesopelia g. galapagoensis</i>	Indefatigable	11	20	12	10	
<i>Nesopelia g. galapagoensis</i>	Barrington	12	4			
<i>Nesopelia g. galapagoensis</i>	Chatham	1	2			
<i>Nesopelia g. galapagoensis</i>	Hood	11	16		1	
<i>Nesopelia g. galapagoensis</i>	Gardner-near-Hood	6	1			
<i>Nesopelia g. galapagoensis</i>	Charles	3	1	2	9	
<i>Nesopelia g. galapagoensis</i>	Gardner-near-Charles	2	1			

51. *Coccyzus melacoryphus* Vieillot

Coccyzus melanocoryphus Ridgway, 1889, p. 113 (Chatham and Charles islands); 1897, p. 581.—Rothschild & Hartert, 1899, p. 174.—Snodgrass & Heller, 1904, p. 268.—Gifford, 1919, p. 195 (life history).

Coccyzus melacoryphus Rothschild & Hartert, 1902, p. 403 (life history).—Ridgway, 1916, p. 35.—Cory, 1919, p. 338.

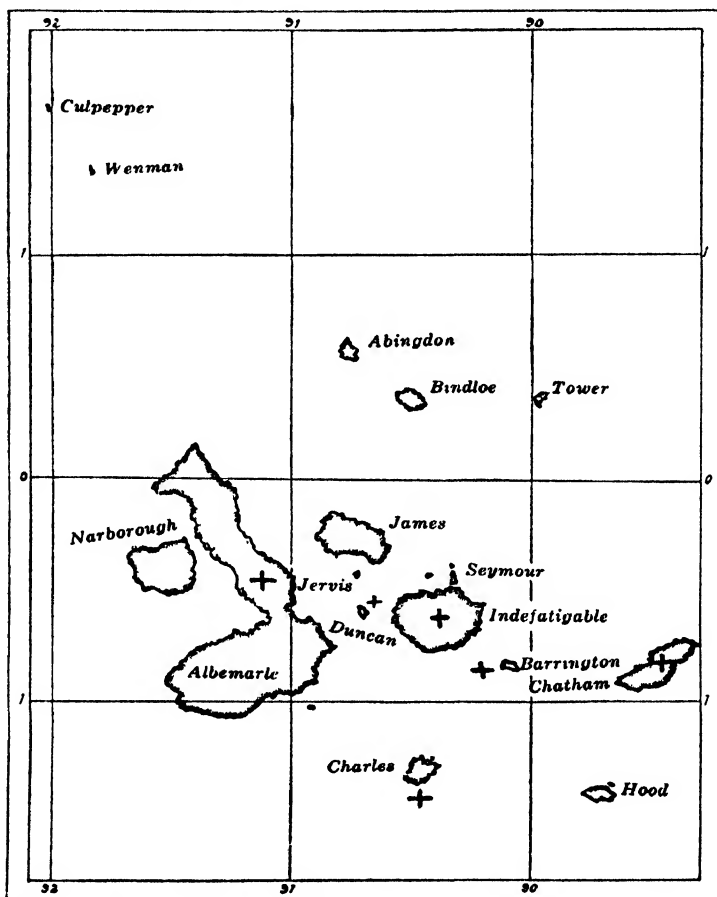


Fig. 4. Map showing distribution of *Coccyzus melacoryphus* in the Galapagos Islands. Symbols indicate islands where recorded.

HABITAT.—Of widespread distribution on the South American mainland, from Colombia south to Argentina and Peru. Has

been found on the following islands of the Galapagos Archipelago: Albemarle, Duncan, Indefatigable, Barrington, Chatham, Charles.

The Academy series consists of 55 specimens (nos. 2990-3044), as listed in the accompanying table. These were collected during all the months from January to October, inclusive, and as birds were seen also in December (Gifford, 1919, p. 195), the species may be assumed to be a permanent inhabitant of the Galapagos. Rothschild & Hartert (1902, p. 404) point out that it is apparently resident, and also that this is the only Galapagos land bird that is not peculiar to the Archipelago. They remark that it is "somewhat rare and apparently a recent immigrant", the recent arrival being presumably, and justifiably, implied from the close resemblance of island and mainland specimens.

Through the courtesy of Dr. Frank M. Chapman, I received the loan of ten skins of *Coccyzus melacoryphus* from the South American mainland, collected at points in Colombia and Ecuador. The resemblance between these mainland birds and island birds is of the closest; they are practically indistinguishable. Ridgway (1897, p. 581) comments upon the heavier bill of an adult male from Charles Island, but this character is not borne out in our series. The island birds do seem to have on the average slightly longer wing and tail, which is contrary to what might be expected, but the difference is not trenchant. As regards color and markings, I receive the impression that some mainland birds have the bluish tinge on the top of the head somewhat brighter in hue and more sharply defined than in any island specimens, but here, too, the variation is too vague and uncertain to justify anything more than passing comment.

SPECIMENS OF *Coccyzus melacoryphus* IN THE COLLECTION
OF THE CALIFORNIA ACADEMY OF SCIENCES

Island	Adult male	Adult female	Immature male	Immature female	Sex not ascertained
Albemarle	2	2	1	1	
Barrington		1			
Chatham	6	6	1	2	
Charles	5	5	10	12	1

Coccyzus ferrugineus Gould

Coccyzus ferrugineus Gould, 1843, p. 105 (Cocos Id.); 1844, p. 46, pl. 29.—Sclater, 1870, p. 167 (monogr.).—Shelley, 1891, p. 303.—Townsend, 1895, p. 124.—Snodgrass & Heller, 1902, p. 517.—Carriker, 1910, p. 563.—Ridgway, 1916, p. 34.—Gifford, 1919, p. 195 (habits).

COCCYZUS FERRUGINEUS Gould

Type.—British Museum, no. 55.12.19.372. A dismounted bird with glass eyes and wired legs.

HABITAT.—Cocos Island, Costa Rica.

The Academy series consists of four adult birds, one of these being the head only of the specimen (nos. 2986-2989). This is apparently an extremely rare bird in collections. Gould (1843, p. 105; 1844, pl. 29) described and figured the species from a single specimen taken on the voyage of the "Sulphur". Townsend (1895, p. 124) collected two birds, and Snodgrass & Heller (1902, p. 517), one, and these, together with our own series, appear to be, if not all that have actually been obtained, all that have been mentioned in any published reports.

MEASUREMENTS IN MILLIMETERS OF *Coccyzus ferrugineus*

Museum	Number	Sex Age	Locality	Date	Wing	Tail	Culmen	Depth of bill at base	Width of mandible at base	Tarsus	Outer anterior toe with claw	White spot on outer tail feather
C. A. S.	2988	♂ ad.	Cocos Id.	Sept. 8, 1905	133.2	161.2	25.2	10.5	10.0	28.2	24.5	37.0
C. A. S.	2986	♂ ad.	Cocos Id.	Sept. 7, 1905	131.0	158.0	25.0	10.0	9.8	28.2	26.5	32.0
C. A. S.	2987	♀ ad.	Cocos Id.	Sept. 11, 1905	133.0	160.0	24.0	10.2	10.0	28.5	25.2	33.0
C. A. S.	2989	— ad.	Cocos Id.	Sept. 6, 1905	25.5	10.2	10.0

52. *Tyto punctatissima* (Gray)

Strix punctatissima Gray, in Gould, 1841 (= July, 1839), p. 34, pl. 4 (James Id.).—Sclater & Salvin, 1870, p. 323 (Indefatigable Id.).—Salvin, 1876, p. 494 (Indefatigable Id.).—Ridgway, 1897, p. 583.—Rothschild & Hartert, 1899, p. 175; 1902, p. 405 (Albemarle Id.; Chatham Id.).—Snodgrass & Heller, 1904, p. 266 (2 specimens, Albemarle and Seymour; description of nesting burrows and egg).—Gifford, 1919, p. 194 (Narborough, Albemarle, Indefatigable; habits, food, etc.).

[*Strix flammea*] y. *Strix punctatissima* Sharpe, 1875, p. 297.

Tyto punctatissima Ridgway, 1914, p. 616.

Tyto alba punctatissima Hartert, 1929, p. 96.

STRIX PUNCTATISSIMA Gray

Type.—British Museum, no. 37.2.21.244; (probably a female, from its dark color); "Galapagos"; no date; received from Sir W. Burnett and Captain Fitzroy.

According to Darwin (in Gould, 1841, p. 34) only one specimen of this owl was obtained during the visit of the "Beagle" to the Galapagos, this one being shot by Captain Fitzroy upon James Island in October.

HABITAT.—The Galapagos Archipelago, where, so far as known, it is restricted to the large central islands. Specimens have been taken on James, Indefatigable, Seymour, and Albemarle. There is a definite sight record from Narborough, and there is an uncertain sight record from Chatham.

DESCRIPTION.—*Adult male* (Indefatigable Island). General color above, on back and upper surface of wings, dark gray, vermiculated with white, and varied with small elongated white spots which are bordered with black. Edge of facial ruff, sides of neck and middle portion of feathers on top of head, ochraceous-buff. Primaries and secondaries with indistinct dusky cross bars; exposed edge of primaries ochraceous-buff; primaries, secondaries, and tertials with fairly sharply defined whitish terminal or sub-terminal spots. Tail whitish below, gray above, tinged with ochraceous, crossed by five dusky bars. Facial ring pure white, tinged with dark brown in front of eye, bordered by a sharply defined dark brown ring. Breast pure white, upper breast immaculate, lower breast with small blackish (mostly sagittate) markings. On the flanks these markings are heavier, with some irregular cross bars, and with a faint vinaceous tinge to the feathers. Under tail coverts pure white with a few small grayish spots. Bill dull yellowish (in dried skin).

Adult female (Indefatigable Island). Much darker throughout than is the male. Upper parts almost black, varied with black and white spots as in the male. Lower parts dark brown, with small black spots (cross bars on feathers of upper breast, roundish spots a little lower down, and mostly sagittate or triangular on

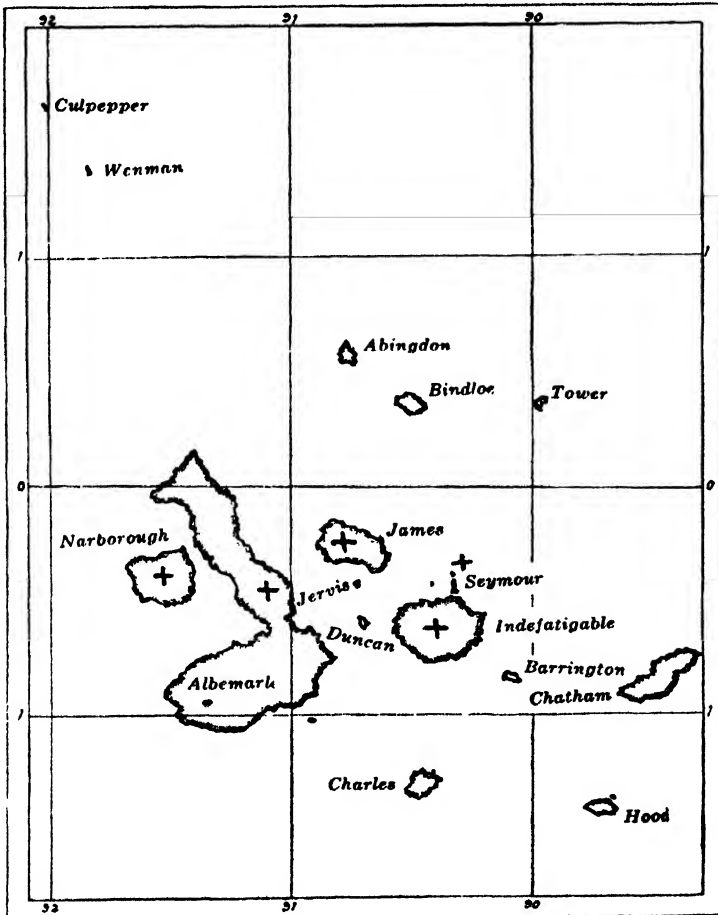


Fig. 5. Map showing distribution of *Tyto punctatissima*. Symbols indicate islands where recorded.

abdomen and flanks); facial ring strongly tinged with vinaceous.

It may aid the above inadequate description of a complicated plumage to say that in pattern and markings this species is essentially like the better known North American Barn Owl (*Tyto alba*

pratincola), but that the Galapagos species is much less rufescent in color. If the two were of the same size (*punctatissima* is much the smaller) they might pass as red (*pratincola*) and gray (*punctatissima*) color phases of the same form. The distinguishing character given by Ridgway (1914, p. 602) for *punctatissima*, in his "key to the species of *Tyto*", namely, "under parts barred with dusky", is almost non-existent. It does not occur at all in adult males from Indefatigable, and to only a slight degree in some females. The female *punctatissima* is much darker brown below and much more heavily marked than is the female *pratincola*, and dorsally it is much blacker, as compared with the strong rufescent tinge of *pratincola*, again suggesting a color phase difference as is described above. The term "color phase" is used here, of course, merely to convey an idea of the sort of color differences that distinguish the two forms, not to imply close specific relationship.

We have fairly adequate series from Albemarle and Indefatigable islands, and the differences between the two lots might be considered as sufficient for subspecific separation. Four adult males from Indefatigable are pure white below and almost immaculate, with small black spots scattered over breast and belly, whereas three from Albemarle have the under parts grayish, sometimes tinged slightly with vinaceous, and with fairly heavy triangular spots, irregular cross bars, or irregular U-shaped markings. Dorsally the Albemarle birds are dark colored, the white spots (conspicuous in the Indefatigable series) reduced to such mere specks that the upper parts appear almost uniformly black. There are comparable differences in the series of females. Our one specimen from James Island, whence came the type specimen of *punctatissima*, is like the Albemarle series, so that if a new name is to be used it should be applied to the Indefatigable bird. At present I see no need of such procedure.

There are fairly well defined sexual differences in this species, about the same, I believe, as in the North American form. In each case the male is paler colored, almost purely white-breasted below, the female much darker and more rufescent. In either form I doubt if the adult male is ever other than white-breasted, or if the adult female ever assumes as pure white a plumage. In our series of *punctatissima* there are several specimens which, by this color standard, might be supposed to belong to the opposite

sex to that indicated upon the label, but, here, just as in similar cases in the North American form, the suspicion arises that the sex might not have been correctly ascertained. It is a point deserving of careful attention from field collectors securing specimens of any form of this genus of owls. (See Hartert, 1929, p. 96.)

This is one of the rarest and least known of the Galapagos birds, though its discovery dates back to the first ornithological exploration of the islands. Fitzroy obtained one specimen upon James Island, which served as the type. Next, Habel collected two birds, one certainly, perhaps both, upon Indefatigable. Sclater and Salvin (1870, p. 323) list one of Habel's birds as from Indefatigable, the other as from an unknown island. Later Salvin (1876, p. 494) gives both as from Indefatigable. Curiously, in Salvin's paper, under "habitat," Abingdon is entered, while farther on in the text the statement is explicitly made that Habel did not find this owl upon Abingdon. Rothschild & Hartert (1899, p. 175) contribute only a dubious sight record from Chatham Island. Their statement in full reads as follows: "Only Darwin and Habel seem to have procured specimens of this owl, while neither Townsend nor Bauer & Adams met with it. Harris believes that he heard it several times, and that he saw it, on Chatham Island, but unfortunately no specimen was procured." A few years later, however, the same authors (Rothschild & Hartert, 1902, p. 405) are able to cite a specimen collected upon Albemarle, August 28, 1900. Snodgrass & Heller (1904, p. 266) collected two "immature specimens", upon Albemarle and Seymour islands, respectively.

Apparently, from the above statements, there were just six specimens of this species extant in collections prior to the Academy expedition, which collected 23, upon James, Albemarle, and Indefatigable. Gifford (1919, p. 194), besides detailing particulars of capture of this series, remarks that "Mr. Beck reported them in the elevated humid, fertile portions of southern Narborough in early April." None was collected upon that island.

SPECIMENS OF *Tyto punctatissima* IN THE COLLECTION
OF THE CALIFORNIA ACADEMY OF SCIENCES

Island	Adult male	Adult female
James		1
Albemarle	3	5
Indefatigable	5	9

MEASUREMENTS IN MILLIMETERS OF *Tyto punctatissima*

Museum	Number	Sex	Locality	Collector	Date	Wing	Tail	Culmen from cere	Tarsus	Middle toe without claw
C. A. S.	2935	♂	Indefatigable	J. S. Hunter	July 16, 1906	216.0	100.0	18.5	53.5	26.0
C. A. S.	2936	♂	Indefatigable	J. S. Hunter	July 16, 1906	225.0	102.0	18.8	53.0	26.2
C. A. S.	2938	♂	Indefatigable	J. S. Hunter	July 16, 1906	204.5	97.2	18.2	52.5	25.5
C. A. S.	2937	♂	Indefatigable	E. W. Gifford	June 17, 1906	212.0	100.5	18.0	50.0	24.5
C. A. S.	2949	♂	Indefatigable	R. H. Beck	Nov. 10, 1905	210.0	101.2	18.5	65.5	26.0
			Average			213.5	100.2	18.4	53.1	25.6
C. A. S.	2941	♂	Albemarle	J. S. Hunter	Apr. 18, 1906	219.0	108.0	18.5	57.0	25.0
C. A. S.	2939	♂	Albemarle	J. S. Hunter	Aug. 24, 1906	212.0	97.0	18.2	54.0	27.0
C. A. S.	2943	♂	Albemarle	J. S. Hunter	Aug. 25, 1906	217.0	101.0	19.2	52.0	24.0
			Average			216.0	102.0	18.6	54.3	25.3
C. A. S.	2945	♀	Indefatigable	J. S. Hunter	Jan. 16, 1906	208.0	97.0	17.0	58.0	26.2
C. A. S.	2951	♀	Indefatigable	J. S. Hunter	June 16, 1906	218.0	103.0	17.5	57.5	25.0
C. A. S.	2952	♀	Indefatigable	E. W. Gifford	July 11, 1906	212.0	100.5	19.8	55.2	26.2
C. A. S.	2957	♀	Indefatigable	E. W. Gifford	July 11, 1906	221.0	106.2	19.5	52.0	27.0
C. A. S.	2946	♀	Indefatigable	E. W. Gifford	July 12, 1906	212.0	101.5	19.2	51.2	26.0
C. A. S.	2948	♀	Indefatigable	J. S. Hunter	July 16, 1906	220.0	99.2	18.2	57.0	25.0
C. A. S.	2940	♀	Indefatigable	R. H. Beck	Nov. 10, 1905	200.0	102.0	18.5	52.0	26.5
C. A. S.	2944	♀	Indefatigable	R. H. Beck	Nov. 10, 1905	218.0	102.0	18.5	56.0	27.0
C. A. S.	2955	♀	Indefatigable	J. S. Hunter	Nov. 14, 1905	218.0	104.2	18.5	57.0	25.5
			Average			214.1	101.7	18.5	55.1	26.0
C. A. S.	2956	♀	Albemarle	E. W. Gifford	Apr. 6, 1906	232.0	113.0	18.8	58.0	27.5
C. A. S.	2954	♀	Albemarle	J. S. Hunter	Aug. 25, 1906	220.0	102.0	18.5	55.5	27.5
C. A. S.	2950	♀	Albemarle	J. S. Hunter	Aug. 30, 1906	218.0	102.0	19.5	52.5	25.5
C. A. S.	2953	♀	Albemarle	J. S. Hunter	Sept. 3, 1906	228.0	103.5	18.2	58.0	26.0
C. A. S.	2942	♀	Albemarle	J. S. Hunter	Apr. 18, 1906	204.0	99.5	19.0	57.0	27.0
			Average			220.4	104.0	18.8	56.2	26.7
C. A. S.	2947	♀	James	J. S. Hunter	Jan. 3, 1906	222.0	103.2	18.5	56.0	25.0

¹ "Length 290.0 Extent 780.0" (collector's measurements)

"Length 339.0 Extent 850.0" (collector's measurements)

53. *Asio galapagoensis* (Gould)

- Otus (brachyotus) galapagoensis* Gould, 1837, p. 10 (inferentially from the Galapagos Islands; no habitat indicated).
- Otus galapagoensis* Gould, 1841 (= Jan., 1839), p. 32, pl. 8 (James Id.).—Sclater & Salvin, 1870, p. 323 (Indefatigable Id.).
- Asio galapagensis* Salvin, 1876, p. 493 (Indefatigable Id.).—Gifford, 1919, p. 193 (Abingdon, Albemarle, Barrington, Champion, Charles, Gardner-near-Charles, Chatham, Duncan, Hood, Indefatigable, Seymour, and Tower; habits).
- [*Asio accipitrinus*] y. *Asio galapagensis* Sharpe, 1875, p. 238 (in list of specimens).
- Asio galapagoensis* Ridgway, 1897, p. 585 (Tower, Hood, Albemarle, Bindloe; reprint of original description; habitat; synonymy; crit.); 1914, p. 668.—Rothschild & Hartert, 1899, p. 175 (Culpepper, Duncan, Barrington, Chatham); 1902, p. 405 (Albemarle and Hood. "Length [in flesh] 15 in., width [spread] 38 in. Eyes orange.").—Snodgrass & Heller, 1904, p. 267 (Barrington and Duncan; habits; measurements; descr. nest and eggs).
- Asio galapagoensis galapagoensis* Cory, 1918, p. 18.

OTUS GALAPAGOENSIS Gould

Type.—British Museum, no. 55.12.19.153; (adult male; see Darwin, in Gould, 1841, p. 33); Galapagos; (no date); collected by C. Darwin. Purchased from Zoological Society.

This specimen is entered as "juv. st." in the Catalogue of Birds, but it is unquestionably adult.

HABITAT.—The Galapagos Archipelago, where definitely reported from the following islands: Culpepper, Abingdon, Bindloe, Tower, James, Duncan, Albemarle, Indefatigable, Seymour, Barrington, Chatham, Hood, Charles, Champion, Gardner-near-Charles.

The Academy series consists of 23 specimens (nos. 2912-2934), apparently all adult. This is a small, dark colored species, of general distribution, practically throughout the Archipelago, and showing no evident tendency toward differentiation upon different islands. Such color variation as occurs is mainly in the shade of the brown ground color of the lower parts, and cannot be correlated with localities. As compared with the mainland *Asio flammeus*, the smaller size and the streaked leg markings of *galapagoensis* appear to be the best differentiating characters. *Galapagoensis* is decidedly darker on the average, but selected specimens of *flammeus* may be found that are as dark as some pale colored island birds. Ridgway's (1914, p. 668) statement: "outer

webs of outer primaries with the buff spaces decidedly smaller than the brown interspaces," is not borne out in our series. The usual thing is for the buff spaces to be the broader at the base of the primary and to diminish in size toward the tip. The amount

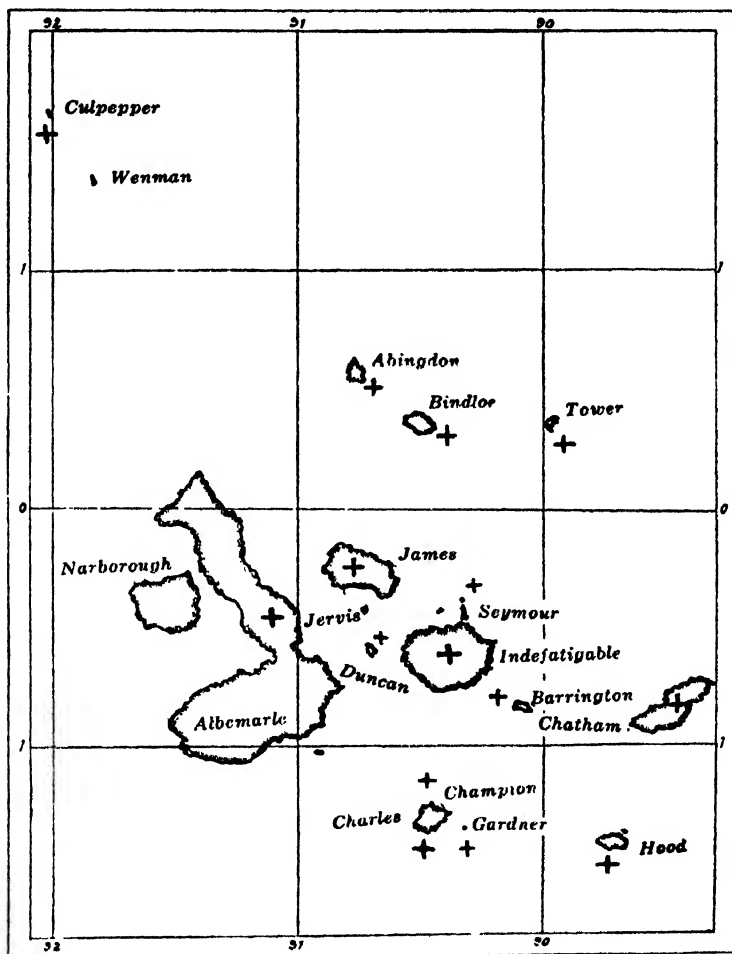


Fig. 6. Map showing distribution of *Asio galapagoensis*. Symbols indicate islands where recorded.

of streaking upon leg and toes is variable, but it is present to some extent upon every specimen. One specimen collected upon Charles Island, May 24, is renewing the rectrices, which are about

half-grown; the flight feathers look old and worn. Another (Champion Island, October 3) has the outermost primary on the right wing partly grown; on the left wing it is just beginning to appear. These partly emerged feathers apparently indicate the completion of the molt in this individual, judging from the fresh, clean aspect of the plumage in general.

SPECIMENS OF *Asio galapagoensis* IN THE COLLECTION
OF THE CALIFORNIA ACADEMY OF SCIENCES

Island	Adult male	Adult female
Tower		2
James	1	1
Duncan		1
Albemarle	1	1
Indefatigable	1	3
Barrington	1	
Chatham		2
Hood	4	1
Charles	3	
Champion	1	

54. *Myiarchus magnirostris* (Gray)

- Myiobius magnirostris* Gray, in Gould, 1841 (= July, 1839), p. 48, pl. 8 (Chatham Island).
Eribates magnirostris Ridgway, 1893, p. 606; 1907, p. 606.—Gifford, 1919, p. 200 (life history).—Hellmayr, 1927, p. 187.
Myiarchus magnirostris Sclater & Salvin, 1870, p. 323.—Sundevall, 1871, pp. 125-127.—Salvin, 1876, p. 493.—Sclater, 1888, p. 262.—Ridgway, 1890, p. 113; 1897, p. 569.—Rothschild & Hartert, 1899, p. 172; 1902, p. 402 (description of nests).—Snodgrass & Heller, 1904, p. 269.

MYIOBIUS MAGNIROSTRIS Gray

Type.—British Museum, no. 56.3.15.10; ad., sex?; Chatham Island; C. Darwin. A date upon the label, "1/4/37", is obviously erroneous as regards time of capture, as Darwin's visit to the Galapagos was in 1835.

DESCRIPTION.—For detailed description of adult and young see Ridgway, 1907, p. 606.

HABITAT.—The Galapagos Islands.

The Academy series consists of 170 specimens (nos. 3414-3583). The species occurs practically throughout the archipelago, having been found upon all the islands of any size except the northernmost, Culpepper. It is rare upon the nearest adjoining island, Wenman, where it was found (in September) apparently for the first time by the Academy expedition (Gifford, 1919, p. 201). Rothschild & Hartert (1899, p. 172) report a specimen "caught on the vessel off Wenman Island."

The specimens in our series were collected during every month except April, and the species is, of course, permanently resident upon at least the larger islands. The recorded occurrences upon and near Wenman suggest some wandering from island to island even though there be no regular migratory movement, something that is as yet unproved.

Eggs were found late in January and during March (Gifford, 1919, p. 203). There are birds in juvenal plumage on hand collected May 25, May 26, and June 1. Adults taken during February on Hood Island are rather worn and faded in appearance though some taken during the same month on other islands are still in fairly good condition. The annual molt seems to be practically finished early in June: the post-juvenal molt must linger in some cases until a month later.

Rothschild & Hartert (1899, p. 172) comment upon the relatively small size of their few specimens from Chatham Island, an observation that is borne out by our more abundant material (see table, p. 87). The difference is slight, however, and the largest Chat-

ham Island birds fall within the range of variation found upon some of the other islands; altogether, subspecific division does not seem justifiable. Color differences are not apparent between series from different islands.

I can not follow Ridgway (1893, p. 606; 1907, p. 606) in the recognition of the genus *Eribates*, erected for this one species,

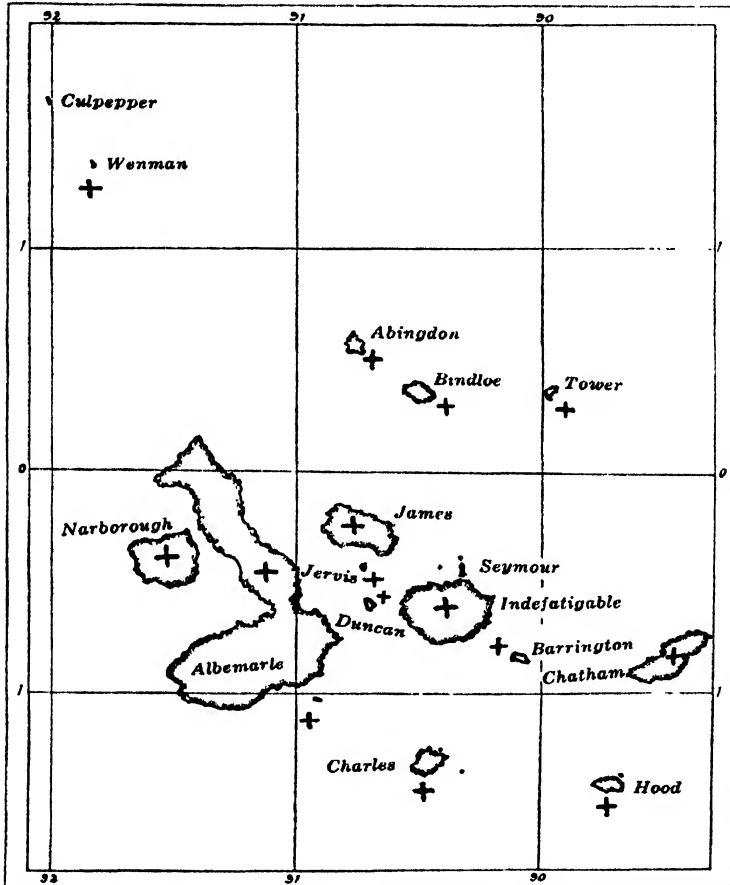


Fig. 7. Map showing distribution of *Myiarchus magnirostris*. Symbols indicate islands where recorded.

which seems to me to be *Myiarchus*-like beyond any question. The generic characters adduced as separating *Eribates* from *Myiarchus* are "tarsus relatively much longer (a little less than one-third as long as wing, about equal to length of bill from rictus), lateral outlines of bill not contracted terminally, and tenth (outermost) primary much shorter (shorter than secondaries)." The long tarsus

is a readily appreciable feature (at least as compared with North American species of *Myiarchus*, all that I have had available), but the other characters described are to my eye too nebulous for dependence. The three features cited, it seems to me, are none of them developed to a degree to justify the generic separation of the species.

In the original description of *Nesotriccus ridgwayi*, of Cocos Island (Townsend, 1895, p. 124), there is at least the implication of close relationship between *Eribates* and *Nesotriccus*, an implication that is reflected in even more positive statements in later publications (see, for example, Hellmayr, 1927, p. 188, footnote). The supposed resemblance between these two species is

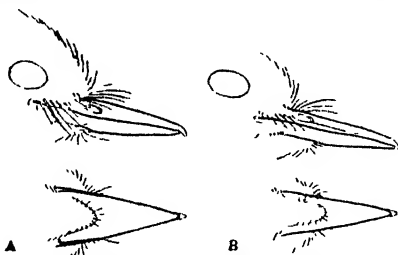


Fig. 8. a, *Myiarchus magnirostris*, male (no. 3461), Chatham; b, *Nesotriccus ridgwayi*, male (no. 3381), Cocos. Natural size.

non-existent to me, while, on the other hand, toward *Myiarchus*, regarding which nothing is said, *magnirostris* has obvious and close resemblance in nearly all details. The affinities of *magnirostris* seem to me to lie clearly with *Myiarchus*. This conclusion was also reached by Rothschild & Hartert (1899, p. 171) and by Snodgrass & Heller (1904, p. 269).

SPECIMENS OF *Myiarchus magnirostris* IN THE COLLECTION
OF THE CALIFORNIA ACADEMY OF SCIENCES

Island	Adult male	Adult female	Sex not ascertained	Juvenal
Abingdon	2	1		
Bindloe	1	1	2	
Tower		1		
James	3	2		
Jervis	1			
Duncan	4	1		
Albemarle	11	7	2	
Brattle	2			
Indefatigable	27	13	5	
Barrington	7	1	4	
Chatham	14	13		
Hood	4	4		
Charles	25	7	2	3

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM) OF

Myiarchus magnirostris

MALES

Number of specimens	Island	Wing	Tail	Culmen	Tarsus	Middle toe with claw
2	Abingdon	67.0-70.2	59.8-64.2	13.2-15.5	21.0-22.0	13.0-13.0
1	Bindloe	71.0	66.5	14.2	22.2	13.0
3	James	72.5 (71.8-73.5)	67.7 (67.0-68.5)	15.1 (14.2-15.5)	22.1 (21.2-22.8)	13.7 (13.2-14.2)
1	Jervis	67.0	62.0	15.8	21.8	13.0
4	Duncan	71.0 (70.0-72.0)	64.9 (63.5-66.0)	15.2 (14.5-16.0)	22.2 (22.0-22.5)	13.3 (13.0-14.0)
10	Albemarle	70.7 (67.5-73.5)	64.8 (60.5-67.5)	15.0 (14.5-16.0)	22.2 (21.5-23.0)	14.0 (13.5-14.5)
2	Brattle	66.5-70.5	63.0-65.0	14.0-15.0	22.0-23.0	14.5-15.0
10	Indefatigable	71.0 (70.0-72.2)	66.2 (63.5-69.8)	14.7 (13.5-15.2)	21.7 (21.0-22.8)	13.3 (12.5-14.0)
7	Barrington	70.2 (68.2-71.5)	65.2 (63.0-67.5)	15.1 (14.5-15.5)	21.5 (20.5-22.0)	13.3 (13.0-13.8)
10	Chatham	68.1 (65.0-70.2)	62.2 (59.0-65.5)	14.1 (13.2-15.0)	21.1 (19.5-22.5)	13.4 (13.0-14.0)
4	Hood	73.2 (71.0-74.5)	67.1 (65.0-68.5)	14.9 (14.2-15.2)	21.3 (20.5-21.8)	14.1 (13.8-14.8)
10	Charles	72.1 (69.2-73.5)	65.8 (63.5-67.8)	15.5 (14.8-16.0)	22.0 (21.5-22.5)	14.8 (14.2-15.2)

FEMALES

1	Abingdon	67.2	60.8	13.5	21.0	13.0
1	Bindloe	66.2	60.2	14.5	21.5	12.2
1	Tower	65.0	59.5	14.5	20.8	12.8
2	James	69.0-71.0	65.0-65.0	14.8-15.5	20.5-21.0	13.0-14.0
1	Duncan	65.0	59.2	15.0	21.5	13.2
7	Albemarle	66.8 (66.2-67.8)	60.7 (59.2-62.5)	14.1 (13.5-14.8)	21.4 (20.5-22.5)	13.3 (13.0-13.8)
10	Indefatigable	67.7 (67.0-68.5)	63.4 (61.5-65.5)	14.4 (13.8-15.0)	21.4 (20.5-23.0)	13.3 (12.5-14.2)
1	Barrington	67.5	61.0	15.2	22.0	12.8
10	Chatham	65.3 (63.0-66.5)	59.3 (55.5-61.5)	14.3 (13.8-14.8)	20.5 (19.5-21.2)	13.4 (13.0-14.0)
4	Hood	69.7 (69.5-70.0)	64.7 (64.2-65.0)	14.6 (14.0-15.0)	21.0 (20.5-21.5)	13.5 (13.2-14.2)
8	Charles	68.2 (64.5-71.2)	62.1 (58.2-63.8)	14.8 (14.2-15.5)	21.8 (21.0-23.0)	13.9 (13.5-14.5)

Genus PYROCEPHALUS Gould

Pyrocephalus Gould, Zool. Voy. "Beagle," iii, 1841 (= July, 1839), 44. Types, "*Pyrocephalus parvirostris* (Gould) and *Muscicapa coronata* (Auct.)" = *Muscicapa rubinus* Boddært.

55. *Pyrocephalus nanus nanus* Gould

Pyrocephalus nanus Gould, 1841 (= July, 1839), p. 45, pl. 7 (orig. descr.; "Galapagos Archipelago").—Sclater & Salvin, 1870, p. 323, part (Bindloe Id.).—Sundevall, 1871, p. 125, part (James Id.).—Salvin, 1876, p. 492, part; 1883, p. 424 (Charles Id.).—Sharpe, 1877, p. 66.—Sclater, 1888, p. 214, part.—Ridgway, 1890, p. 112, part (James, Charles, and Abingdon islands); 1897, p. 572; 1907, p. 478.—Rothschild & Hartert, 1899, p. 172, part; 1902, p. 403 (Barrington and Albemarle islands).—Gifford, 1919, p. 197.

Pyrocephalus nanus nanus Snodgrass & Heller, 1904, p. 270, part. *Pyrocephalus rubinus nanus* Hellmayr, 1927, p. 93, part.

Pyrocephalus carolensis Ridgway, 1894, p. 365 (orig. descr.; Charles Id.); 1897, p. 576.

Pyrocephalus abingdoni Ridgway, 1894, p. 367 (orig. descr.; Abingdon Id.); 1897, p. 578.

Pyrocephalus nanus abingdoni Snodgrass & Heller, 1904, p. 271 (Abingdon and Bindloe islands).

PYROCEPHALUS NANUS Gould

Cotype.—British Museum (no catalogue number); ♂ ad.; Galapagos Islands; Charles Darwin. (Specimen "a" of the Catalogue of Birds.)

Cotype.—British Museum, no. 55.12.19.198; ♀ ad.; Galapagos; C. Darwin. (Specimen "b" of the Catalogue of Birds.)

Cotype.—British Museum (no catalogue number); ♀ ad.; Galapagos; C. Darwin. (Specimen "c" of the Catalogue of Birds.)

Specimen "d" of the Catalogue of Birds (entered as one of the types of *P. nanus*) is an example of *Pyrocephalus dubius*. There are also four specimens received from Burnett and Fitzroy that may or may not be considered as cotypes of *P. nanus*. [The date, "January 4, 1837", that is upon the labels of the first two specimens listed above, is when the birds were presented to the Zoological Society. N.B.K.]

PYROCEPHALUS CAROLENSIS Ridgway

Cotype.—United States National Museum, no. 115926; ♂ ad.; Charles Island; April 8 (1888); U. S. Fish Commission, Voyage of the Albatross, 1887-88.

Cotype.—United States National Museum, no. 115928; (♀?; sex not indicated on label); Charles Island; April 8 (1888); U. S. Fish Commission, Voyage of the Albatross, 1887-88.

Cotype.—United States National Museum, no. 115927; ♂ im.; Charles Island; April 8 (1888); U. S. Fish Commission, Voyage of the Albatross, 1887-88. Nos. 115926, 115928, now bear red "type labels."

PYROCEPHALUS ABINGDONI Ridgway

Type.—United States National Museum, no. 116134; ♂ ad.; Abingdon Island; April 16 (1888); U. S. Fish Commission, Voyage of the Albatross, 1887-88.

DESCRIPTION.—Approximate size, color and markings generally as in other species of *Pyrocephalus* (see Ridgway, 1907, p. 471). *Adult male*: Pileum and under parts brilliant red. In the brightest specimens the pileum is close to "spectrum red" (Ridgway), the under parts to "scarlet-red"; there is considerable variation in the intensity of these colors. Lores, auricular region, back, wings and tail, sooty blackish (fresh plumage) to sooty brownish (faded plumage), with, in fresh plumage, occasional faint grayish margins to feathers of any part. *Adult female*: Upper parts (including pileum, sides of head, back, wings and tail) brownish, in freshest and darkest state close to "raw umber." Chin, throat and malar region almost pure white, abruptly defined against the brownish cheeks and the yellowish under parts. From the upper breast posteriorly the under parts are yellow or buffy-yellow, ranging in different individuals from "baryta yellow" to "buff yellow". Upper breast, occasionally sides of breast, with fine but distinct longitudinal dusky streaks. In just one specimen these streaks are lacking. *Immature male*: Generally similar to adult female but brighter yellow below and with slightly heavier streaks on breast. In other stages, possibly of immaturity, the lower parts are pale red, in varying intensity, with dusky streaks on breast, and with pileum partly red, the red feathers dusky tipped. *Juvenal* (both sexes): Generally similar to adult female, but with brownish feathers of upper parts (pileum, dorsum, wing coverts, flight feathers and rectrices) margined with buff, cinnamon or whitish, and with breast, sides and flanks more heavily and extensively streaked.

HABITAT.—The greater part of the Galapagos Archipelago. Reported from the following islands: Wenman, Abingdon, Bindloe, James, Jervis, Duncan, Albemarle, Narborough, Barrington, and Charles.

In the Academy catalogue specimens of *Pyrocephalus nanus nanus* and *P. n. intercedens* are entered, intermixed, under numbers 3045-3267. There are 182 specimens of *nanus* in the collection.

Pyrocephalus nanus Gould (1841, p. 45, pl. 7) was described from the "Galapagos Archipelago," no particular island being specified. The female figured in Gould's colored plate is of rather a brighter, clearer shade of yellow than is usual in the form to which I am restricting the name *nanus*, though it can be closely matched by selected specimens. In that particular it is more nearly like *intercedens*, but it is figured with a streaked breast, which that subspecies has not.

Ridgway (1894) restricted the name *nanus* to the bird of James Island, naming in addition several other forms, of which I can recognize *intercedens* of Indefatigable Island. Rothschild & Hartert (1899, p. 172) refuse recognition to *intercedens*, which I can understand after examining their James Island series, more extensive than our own. Of eight adult males from James in the Rothschild collection one is like *intercedens*; of five females, one is almost unmarked below (as in *intercedens*) and all display a slight leaning toward the color of that form. Our own birds from James Island (including four adult males and five adult females) are essentially like those from Charles. On the whole it would seem that James Island birds are intermediate in appearance between those of Albemarle and Charles on the one hand, and those of Indefatigable (*intercedens*) on the other, though nearer the former. I therefore use the name *nanus* for the form occupying all of the northern and western islands as well as Charles Island, with James Island as type locality but not occupied by birds showing the best manifestation of subspecific characters. With this preliminary disposal of names, I am using our extensive Charles Island series of 127 skins, including all the variation (seasonal, age, etc.) that is represented in part from other islands, as a basis for comparison with all the other series.

Charles Island *nanus*, compared with *intercedens* of Indefatigable Island, presents the following characters: The male bird (from Charles Island) is of a brighter shade of red. The female has

the yellow of the under parts of a more buffy shade, and with few exceptions has the breast and sides sharply, sometimes heavily, streaked with dusky.

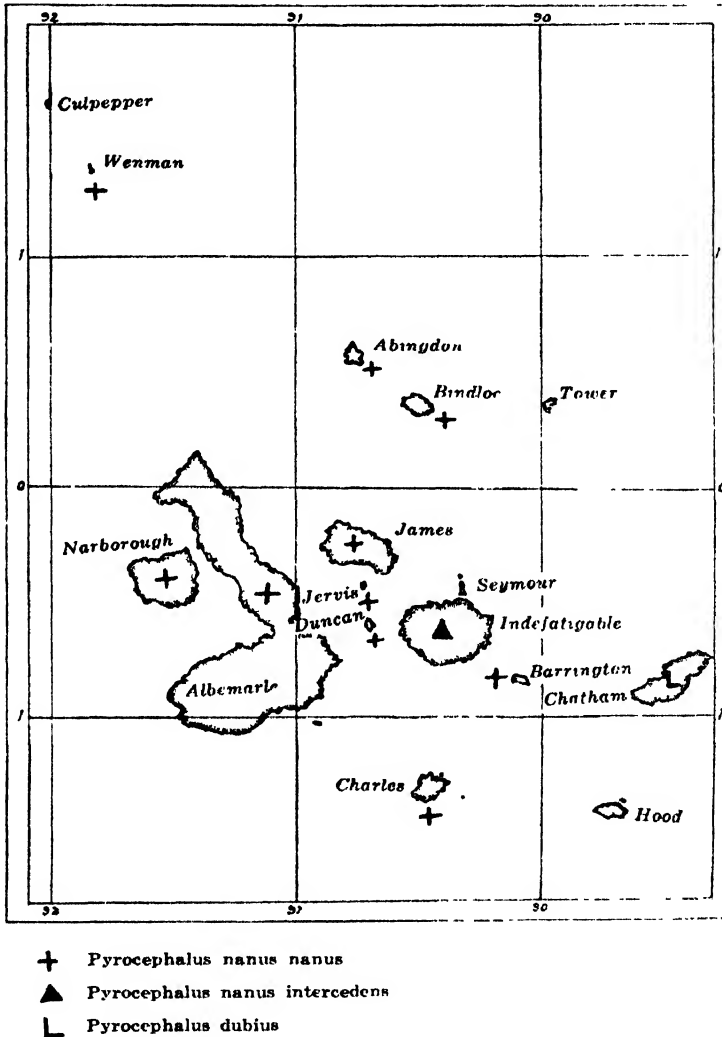


Fig. 9. Map showing distribution of *Pyrocephalus nanus nanus*, *P. n. intercedens*, and *P. dubius*. Symbols indicate islands where recorded.

Going north from Charles Island, birds from the other islands, as illustrated in our series, present the following features. Dun-

can: Seven specimens, all in excessively worn plumage but apparently the same as on Charles. Albemarle: The vermilion flycatcher of this island was referred to *intercedens* by Ridgway (1896, p. 575), but judging from the series at hand it does not belong to that subspecies. Male birds are intermediate between those from Charles and those from Indefatigable, but nearer the former. Of four adult females, one resembles *intercedens* in shade of yellow below, but has an extensively white throat and streaked breast; three are almost pure white below, streaked on breast and flanks. Juveniles from Albemarle differ from the same stage from Charles in being of a brighter yellow below, Charles birds being more buffy. There is no specimen of *intercedens* at hand entirely in juvenal plumage, but those with remnants of that plumage are very similar to young from Albemarle. Altogether, the *Pyrocephalus* from Albemarle Island is intermediate between *intercedens* of Indefatigable and *nanus* of Charles, but is nearer the latter. James: Of the four adult males, two are bright red, exactly like birds from Charles, and two are orange below, brighter on the throat. Eleven additional specimens, in worn and faded plumage, are sparsely streaked or nearly immaculate below. They are most nearly like Charles Island birds. Jervis: Three specimens, in very worn plumage, are apparently like those from Charles. Bindloe: The four adult males are paler than the brightest from Charles, but can be matched with some specimens from that island. The two females are nearly like those from Charles, but brighter yellow, less buffy, on the belly. Abingdon: One immature male, in very worn plumage, pale colored and unstreaked below. No comparisons can be based on this specimen. Wenman: One female, exactly like those from Charles.

Three males and one female from Barrington Island in the Rothschild collection are of the *nanus* type. This is rather curious in that Barrington lies between Indefatigable (habitat of *intercedens*) and Chatham (habitat of *dubius*), nearer the former, and is much farther distant from Charles, the nearest island occupied by *nanus*.

To sum up: Our series shows two well marked extremes, in the birds from Indefatigable and from Charles Island, respectively, *intercedens* from Indefatigable, *nanus* from Charles. Birds from the several other islands listed above are either exactly like those from Charles or are somewhat intermediate toward the form upon

Indefatigable. These intermediates are all most nearly like the bird upon Charles, and the whole aggregation should go under the same name, *nanus*. Our series of *Pyrocephalus* does not afford grounds for the recognition of the forms *carolensis* (Ridgway, 1894, p. 365) from Charles Island, or *abingdoni* (Ridgway, *loc. cit.*, p. 367) from Abingdon and Bindloe. It would not be surprising, though, if, with series from all the other islands as extensive as those here available from Indefatigable and Charles, slight average differences were to be seen that are not now apparent.

Plumage stages, as illustrated in our series, are as follows. Half-grown nestlings were taken on February 28, and others in juvenal plumage up to May 28. Specimens taken early in June are undergoing the post-juvenal molt. During the second week in May and for three weeks following, there are adults just finishing the annual molt, and male birds (presumably immature) molting into the red plumage. From early July until latter October birds are at their best. Females and immature males show the effects of wear and fading more quickly than the red males, and such wear shows markedly before the end of November. From December until the next molt, which probably begins early in March (there is a dearth of specimens taken in January, February and March), most specimens are in very worn plumage. There are parti-colored males, collected in February and March, that do not seem to be molting. These have much red on breast and belly, and they have on the top of the head feathers that are partly red and partly (tipped with) dusky.

56. *Pyrocephalus nanus intercedens* Ridgway

Pyrocephalus intercedens Ridgway, 1894, p. 366 (orig. descr.; Indefatigable Id.); 1897, p. 575.—Hartert, 1922, p. 385 (particulars of type specimen, in Rothschild Museum).

Pyrocephalus nanus Rothschild & Hartert, 1899, p. 172, part, crit.—Ridgway, 1907, p. 478, part.

Pyrocephalus nanus nanus Snodgrass & Heller, 1904, p. 270, part.

Pyrocephalus rubinus nanus Hellmayr, 1927, p. 93, part.

PYROCEPHALUS INTERCEDENS Ridgway

Cotype.—Rothschild Museum; ♂ ad.; Indefatigable Island: August 5, 1891; Dr. G. Baur; orig. no. 418.

Ridgway indicated no type specimen. but based his description upon three skins (adult male, adult female, and immature male) in the Baur collection, with comments upon still others in the U.

S. National Museum. Of the three Baur skins the adult male is the only one I found in the Rothschild collection. As it bears a red "type label" of the U. S. National Museum it was evidently regarded by Ridgway as the type specimen.

DESCRIPTION.—*Adult male*: Generally similar to *nanus* but with the red areas of a slightly different (paler and more orange) shade. *Adult female*: Upper parts brownish, about as in *nanus* but (especially on the head) with a slight suffusion of yellow. A fairly distinct yellowish streak from the nostril over and behind the eye. Lower parts yellowish, close to "apricot yellow" in the brightest individuals, paling in others to whitish with a faint yellow suffusion. The throat is always paler than the rest of the lower parts, sometimes whitish, but never with a well defined whitish area as in *nanus*. Lower parts usually immaculate, occasionally with faintly indicated dusky streaks on sides of breast. *Juvenal*. Generally like adult female, but (as in *nanus*) with feathers of upper parts, wings and tail, margined with buffy or whitish. Breast streaked, but not so heavily and extensively as in young *nanus*. There are male birds in (assumedly) immature stages about as in *nanus*.

HABITAT.—Indefatigable Island.

Described by Ridgway in 1894 (p. 366) from Indefatigable Island, a range that was later extended to include Albemarle Island (Ridgway, 1897, p. 575). Differentiating characters, compared with *P. nanus*, of James Island, and "*carolensis*," of Charles Island, included differences in shade of red of adult males, and in color and markings, principally on the lower parts, in the females. The adult female of *intercedens* was described as follows: "Above deep hair brown, the pileum strongly tinged with yellow; superciliary stripe, extending from nostrils to posterior angle of eye (broadest anteriorly), light buff-yellowish; malar region, chin. and throat very pale maize yellow: rest of under parts light chrome or deep naples yellow" (Ridgway, 1897, p. 575). The existence of this form has been discredited by later writers. Rothschild & Hartert (1899, p. 172), and Snodgrass & Heller (1904, p. 270), deny recognition to *intercedens*, and Ridgway, himself, later (1907, p. 478) places the name in synonymy under *nanus*.

Our collection contains 41 from Indefatigable Island. The adult males are of a different shade of red than those from other islands, and our series of females certainly displays the characters

ascribed to *intercedens* by Ridgway (*loc. cit.*). In the Academy collection, comparisons are best made with the series of *nanus* from Charles Island, as having the most extensive representation of any of the islands. In the adult males the difference in color is such as to be readily apparent on side by side comparison of single birds or of series. In *intercedens* the red of pileum and underparts is paler, more of an orange shade; even when the paler colored specimens of *nanus* are chosen for comparison there is an appreciable difference between the two in the shade of red. In the male *intercedens* more white shows through the red on the chin and throat.

In adult females the difference in color below is readily apparent. In *intercedens* the underparts are of a clearer yellow, a color that in the more highly marked specimens extends with but a slight paling almost to the bill. There is very little white on the chin. Even in the paler-colored individuals there is not the rather abruptly white chin and throat that characterizes the female of *nanus*. The underparts are immaculate, or with but a few slight flecks of dusky on the breast. In *nanus* the chin and throat are white, slightly or not at all tinged with yellowish, and this whitish area is generally rather sharply defined against the yellowish breast; breast and sides are of a slightly more buffy yellow than in *intercedens*, and are marked with sharply defined dusky shaft streaks. One specimen of *nanus* (no. 3158) has the under parts well-nigh immaculate, as in *intercedens* but of a different shade; another (no. 3142) has the underparts colored as in pale examples of *intercedens*, but the throat is extensively white and the breast lightly streaked. Differences in the immature plumages of *intercedens* and *nanus* seem to parallel those in the adult female, though the available series of young *intercedens* is too limited to fully demonstrate this.

Snodgrass & Heller (1904, p. 270) had no specimens from Indefatigable, basing their objection to the recognition of *intercedens* upon their series from Albemarle. In this I can agree with them, as the Albemarle bird, judging from our series, is not *intercedens*, but their argument has no bearing upon the status of the form on Indefatigable.

The use of the trinomial, *Pyrocephalus nanus intercedens*, may be criticized, as obviously there is no geographical continuity between the ranges of the forms *nanus* and *intercedens*. It seems

to me, however, that it is best to treat the two as subspecies, as has been done generally with similarly differentiated island forms in our North American list. For one thing, there is individual intergradation, affecting one character or another, between the two. Obviously, also, *nanus* and *intercedens* are far more nearly alike, more nearly related, than either is toward *Pyrocephalus dubius*, of Chatham Island, and a false idea would be conveyed by using the binomial for each of the three forms. On the other hand, I do not feel that I can follow Hellmayr (1927, p. 93), who treats both *nanus* and *dubius* as subspecies of the mainland species *Pyrocephalus rubinus*. In degree of difference, in constancy of characters, and in geographical distribution, it seems to me that *rubinus*, *nanus* and *dubius* meet the requirements for specific distinction.

57. *Pyrocephalus dubius* Gould

Pyrocephalus dubius Gould, 1841 (= July, 1839), p. 46 (orig. descr.; "Galapagos Archipelago".—Ridgway, 1894, p. 368; 1897, p. 579; 1907, p. 480.—Rothschild & Hartert, 1899, p. 173; 1902, p. 403.—Rothschild, 1902a, p. 47 (nest and eggs).—Snodgrass & Heller, 1904, p. 272.—Gifford, 1919, p. 198 (life history).
Pyrocephalus minimus Ridgway, 1890, p. 118, in text.
Pyrocephalus nanus Salvin, 1876, p. 492, part.—Sclater, 1888, p. 214, part.
Pyrocephalus rubinus dubius Hellmayr, 1927, p. 93.

PYROCEPHALUS DUBIUS Gould*

Cotype.—British Museum, no. 37.5.13.210; ♀ ad.; (Galapagos); Gould. (Specimen "e", under *P. nanus*, in Catalogue of Birds.)

Cotype.—British Museum, no. 55.12.19.184; ♀ ad.; Galapagos; C. Darwin. (Specimen "d", under *P. nanus*, in Catalogue of Birds.)

?*Cotype*.—British Museum, no. 37.2.21.299; ♂ ad.; Galapagos; Burnett and Fitzroy.

PYROCEPHALUS MINIMUS Ridgway

Type.—United States National Museum, no. 115961; ♂ ad.; Chatham Island; April 5 (1888); U. S. Fish Commission, Voyage of the Albatross.

*Mr. Kinnear supplies the following additional facts, with his own ideas, on the matter of the type or types of *P. dubius*.—"No. 55.12.19.184 is Gould's type, which came to the British Museum from the Zoological Society. No. 87.5.13.210 is wrongly entered as the type of *dubius* in the Catalogue of Birds (specimen e'); it was purchased from Gould and according to the Register came from 'Brazil'.

"There are two specimens from Burnett and Fitzroy (not types) with particulars as follows: 37.2.21.397, ♂ juv., Chatham Id., original no. 400; 37.2.21.399, ♂, Charles Id., original no. 404. *Dubius* is not supposed to occur anywhere except on Chatham, but Fitzroy was very careful and all, or nearly all, of his birds have the original numbers." N.B.K.

DESCRIPTION.—*Adult male*: Similar to *nanus* in color pattern, but decidedly smaller and with red of lower parts decidedly paler (approximately "peach red" in the brightest individuals). *Adult female*: Upper parts generally brownish (close to raw umber), whole top of head strongly suffused with buffy, and with a broad buffy streak from the nostril over and behind the eye. Lower parts immaculate, close to "orange buff" in the darkest individuals. As in the other forms of *Pyrocephalus* there are males, presumably immature, that are indistinguishable from the female, and others with the lower parts mixed buffy and red in varying degrees. *Juvenal*: Sexes alike. Generally similar to adult female but dusky upper parts (pileum, dorsum, wing coverts and flight feathers) with feathers margined or tipped with rusty cinnamon. Outer web of outer rectrices and tips of the others cinnamon rufous. Below faintly yellowish, immaculate on throat and middle of abdomen. Breast, sides and flanks with fine dusky streaks lengthwise of feathers. (Described from three young in the Rothschild Museum.)

HABITAT.—Chatham Island.

Our series includes the following specimens: Adult (red) males, 24; females, 39; immature males, 31; sex undetermined, 12. Total 106 (nos. 3268-3373). They were collected on the following dates: January 25, 27, 29; February 8, 22, 23; July 5, 6, 7; September 8, 10; October 16, 17, 18.

Dubius is sufficiently removed from *nanus* to be treated as a distinct species. The male *dubius* varies in the shade of red of the lower parts so that the brightest colored specimens of *dubius* are closely similar to the palest of *nanus*, and intergradation between the two might be considered to exist to that extent. This, however, is hardly a fair criterion to apply. In measurements, and in color of female and immature there appears to be no overlapping. The male *dubius* is in shade of red more nearly like *nanus* than like *intercedens*.

The immature male, in general like the female, differs slightly from the mode in that sex in paler ventral coloration and in having some striation on the breast. Such breast markings in the female are either altogether wanting or are very faintly indicated. There are presumably immature males collected during the first two weeks in July (soon after the time of the annual and the post-juvenal molts) that are in the female plumage throughout, barring the slight variation above indicated. There are other males taken

at the same time that are partly red below and on the pileum. This may mean that the male bird requires two years to acquire its brightest plumage, going, after the post-juvenal molt, into the female plumage, after the next annual molt into a parti-colored plumage, and after the third molt into the bright red plumage of the fully mature bird. Or it may mean that some individuals molt from juvenal into this parti-colored plumage and some into female plumage, all assuming the fully mature, red plumage in the second year. I am inclined to take the latter view, though there are no such specimens available as would serve to corroborate it. No molting examples of *dubius* were collected, and no juveniles. In an account of the habits of the bird, Gifford (1919, p. 200) remarks that "birds in plumage intermediate between red and buff were rare." They should be common if this were a stage regularly gone through by all males.

In the female, besides the distinctively ochraceous-buff color of the lower parts, so different from the color in *nanus* and *intercedens*, there is a buffy suffusion on the pileum, comparable to the red crest in the male, a distinctly marked area such as is not seen in the other forms.

SPECIMENS OF *Pyrocephalus* IN THE COLLECTION OF THE CALIFORNIA
ACADEMY OF SCIENCES

Name	Island	Adult male	Adult female	Immature male	Sex undetermined	Young
<i>Pyrocephalus n. nanus</i>	Wenman		1			
<i>Pyrocephalus n. nanus</i>	Abingdon			1		
<i>Pyrocephalus n. nanus</i>	Bindloe	4	1		1	
<i>Pyrocephalus n. nanus</i>	Albemarle	10	5	2		6
<i>Pyrocephalus n. nanus</i>	James	4	5	4	2	
<i>Pyrocephalus n. nanus</i>	Jervis	1	2			
<i>Pyrocephalus n. nanus</i>	Duncan	3	2	2		
<i>Pyrocephalus n. nanus</i>	Charles	40	27	26	6	27
<i>Pyrocephalus n. intercedens</i>	Indefatigable	19	8	9	5	
<i>Pyrocephalus dubius</i>	Chatham	24	39	31	12	

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM) OF *Pyrocephalus**nanus nanus*, *P. n. intercedens* and *P. dubius*

Number of specimens	Sex	Name	Island	Wing	Tail	Culmen	Tarsus	Middle toe and claw
10	♂	<i>Pyrocephalus n. nanus</i>	Charles	63.6 (62.5-66.0)	53.4 (51.5-55.0)	12.0 (11.5-12.2)	18.1 (17.5-18.2)	13.7 (12.2-15.0)
10	♂	<i>Pyrocephalus n. intercedens</i>	Indefatigable	62.6 (60.2-64.0)	53.0 (51.5-55.0)	12.2 (11.0-13.0)	18.4 (17.5-19.0)	13.8 (13.0-14.5)
10	♂	<i>Pyrocephalus dubius</i>	Chatham	57.1 (56.0-58.0)	48.3 (47.5-49.2)	11.2 (10.8-11.8)	16.8 (16.0-17.0)	12.4 (12.0-12.8)
10	♀	<i>Pyrocephalus n. nanus</i>	Charles	61.6 (60.5-63.5)	52.8 (51.0-54.0)	11.6 (11.2-12.0)	18.3 (17.8-19.0)	13.2 (13.0-13.5)
8	♀	<i>Pyrocephalus n. intercedens</i>	Indefatigable	61.0 (60.0-64.0)	52.4 (49.0-55.5)	11.8 (11.0-12.2)	18.1 (17.0-19.0)	13.3 (13.0-13.8)
10	♀	<i>Pyrocephalus dubius</i>	Chatham	55.1 (54.0-56.2)	48.5 (47.2-50.0)	10.9 (10.0-12.0)	16.3 (16.0-17.0)	11.7 (11.2-12.0)

Genus NESOTRICCUS Townsend

Nesotriccus Townsend (C. H.), Bull. Mus. Comp. Zool., XXVII, No. 3, July, 1895, 124. (Type, *N. ridgwayi* Townsend.)

Nesotriccus ridgwayi Townsend

Nesotriccus ridgwayi Townsend, 1895, p. 124, pl. (Cocos Id.).—Snodgrass & Heller, 1902, p. 518.—Ridgway, 1907, p. 482.—Gifford, 1919, p. 242.

NESOTRICCUS RIDGWAYI Townsend

Type.—United States National Museum, no. 131691; ♂ ad.; Cocos Island, Pacific Ocean; February 28, 1891; C. H. Townsend.

DESCRIPTION.—For detailed description see Ridgway, 1907, p. 482.

HABITAT.—Cocos Island, Costa Rica.

The Academy series includes 35 specimens, all adults, collected September 4 to 13, 1905 (nos. 3379-3413). Ridgway gives a detailed description of the adult male, the female being then unknown. Our series includes both sexes, which are exactly alike in color and markings. As remarked under *Myiarchus magirostris*, I do not consider *Nesotriccus ridgwayi* as being closely related to that species, as it has been regarded by others. It seems to me that its nearest affinities must lie in some other direction.

58. *Progne modesta* (Neboux)

Hirundo modesta Neboux, 1840, p. 291 (Charles Island).—Sundevall, 1871, p. 125.

Progne modesta Gould, 1841 (= July, 1839), p. 39, pl. 5.—Ridgway, 1897, p. 505; 1904, p. 43.—Snodgrass & Heller, 1904, p. 347.

Hirundo concolor Gould, 1837, p. 22 (Galapagos Archipelago).

Progne concolor Salvin, 1876, p. 476.—Sharpe, 1885, p. 176.—Ridgway, 1890, p. 105.—Rothschild & Hartert, 1899, p. 152; 1902, p. 386.—Gifford, 1919, p. 205 (life history).

HIRUNDO MODESTA Neboux

Type.—Museum National d'Histoire Naturelle, Paris; ♀; "La Venus, 1839, I. Galapagos (Neboux)."

Data supplied by J. Berlioz, who writes me as follows: "I find in our collection only a single specimen of Swallow brought by "La Venus" from the Galapagos Islands. This specimen, mounted but still in rather good condition, bears naturally no original label, as most of the birds of those older times, but only a collection label. There can be little doubt that it is really the type of Neboux's *Hirundo modesta*, as, in the list of specimens brought by Neboux in 1839 and still preserved in our old registers, there is only one Swallow mentioned."

HIRUNDO CONCOLOR Gould

Type.—British Museum, no. 60.1.16.54; (♂ ad.); Galapagos; no date: "Beagle".*

A dismounted bird with glass eyes and wired legs; in fair condition.

HABITAT.—The central and southern islands of the Galapagos Archipelago. Reported thus far from the following islands: James, Albemarle, Duncan, Daphne, Seymour, Indefatigable, Barrington, Chatham, Charles, and Hood.

The Academy series consists of 56 specimens (nos. 3588-3643), as listed in the accompanying chart, not a sufficient number, or from enough places to demonstrate the existence of any variation between birds from different islands.

Presumably immature males collected during March, April and May, show small patches of glossy black feathers scattered through the otherwise brownish body plumage. Two birds marked as males that were collected later in the year, in August, are of uni-

*Ex Gould's collection; probably purchased from the Zoological Society. N.B.K.

formly brownish body color, as are the females, and it is possible that in these two the sex is wrongly indicated. The specimens in our series were taken in February, March, April, May, August,

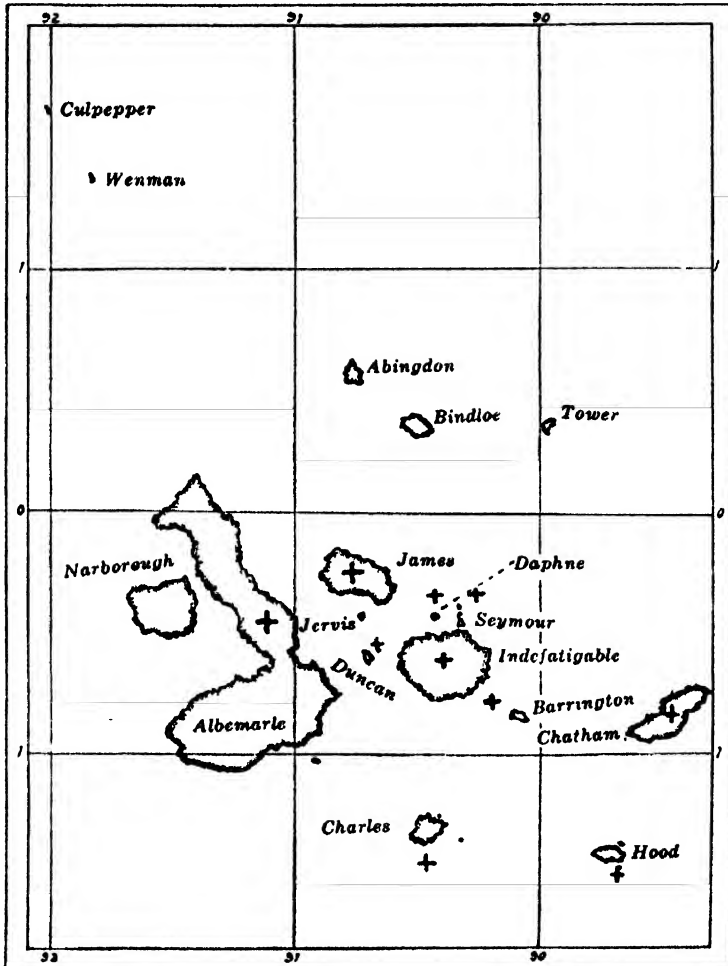


Fig. 10. Map showing distribution of *Progne modesta*. Symbols indicate islands where recorded.

October and November, and the species was seen, besides, in January, September, and December (Gifford, 1919, p. 205). It is not known to migrate from the Galapagos at any season.

SPECIMENS OF *Progne modesta* IN THE COLLECTION
OF THE CALIFORNIA ACADEMY OF SCIENCES

Island	Adult male	Immature male	Female
Albemarle	16	9	21
Seymour			3
Indefatigable			1
Chatham	1		1
Charles	2	1	1

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM) OF *Progne modesta*

Number of specimens	Island	Wing	Tail	Culmen	Tarsus	Middle toe with claw
10 males	Albemarle	124.9 (121.0-128.0)	63.2 (60.0-65.2)	10.0 (9.5-10.2)	11.1 (10.8-11.5)	14.0 (13.5-14.5)
10 females	Albemarle	120.5 (115.0-123.5)	59.0 (51.8-62.5)	9.3 (9.0-10.2)	11.0 (10.5-11.5)	14.5 (13.5-15.0)

59. *Hirundo erythrogaster* Boddært

Hirundo rustica erythrogastra Rothschild & Hartert, 1899, p. 152
(Charles and Chatham islands).

Hirundo erythrogaster Snodgrass & Heller, 1904, p. 348 (Hood Id.).
—Gifford, 1919, p. 205 (Cocos Id.; Charles Id.).

A transient species that, like the Bob-o-link, is of more than casual occurrence in the Galapagos. "Five skins of the North American swallow were procured in October and November on Charles and Chatham Islands" (Rothschild & Hartert, *loc. cit.*). "In May we saw several individuals flying about over Hood" (Snodgrass & Heller, *loc. cit.*). The Academy expedition collected three specimens, an immature male, 40 miles south of Cocos Island, September 1, 1905; an immature male, "25 miles from Cocos Island," September 2, 1905, and an adult male, on Charles Island, October 12, 1905 (nos. 3585-3587). (See also Gifford, *loc. cit.*).

Genus NESOMIMUS Ridgway

Nesomimus Ridgway, Proc. U. S. Nat. Mus., XII, Feb. 5, 1890, 102, footnote. Type, *Orpheus melanotis* Gould. (For generic characters and for detailed descriptions of species see Ridgway, 1907, pp. 244-257.)

The genus *Nesomimus* is peculiar to the Galapagos Islands, where it is (or has been) found on all of the larger islands and on most of the smaller ones. Only one form (species or subspecies) occurs upon any one island. Of the more recent students of the genus, Rothschild & Hartert (1899, pp. 142-147) recognize five species, *trifasciatus*, *macdonaldi*, *adamsi*, *melanotis*,

and *parvulus*, with six subspecies under *melanotis* and two under *parvulus*, making eleven forms in all; Snodgrass & Heller (1904, pp. 358-372) recognize five species, *trifasciatus*, *macdonaldi*, *adamsi*, *melanotis*, and *personatus*, with four subspecies under *melanotis* and four under *personatus*, again eleven forms; and Ridgway (1907, pp. 244-257) recognizes the same eleven forms as Snodgrass & Heller, but regards them all as distinct species. Snodgrass & Heller relegate to synonymy one form, *N. parvulus affinis*, that was recognized by Rothschild & Hartert, and they describe one additional form, *N. melanotis dierythrus*.

In my own study of the genus, here presented, I have felt compelled to adopt a nomenclature and a systematic treatment that are somewhat different from any of those just mentioned. I recognize the species *trifasciatus*, *macdonaldi*, *melanotis* (= "*adamsi*"), and *parvulus* (= *melanotis* of most authors), with the last named divided into the following seven subspecies, *barringtoni*, *bauri*, *parvulus*, *bindloei*, *personatus*, *wenmani*, and *hulli*, ten forms in all. *Nesomimus affinis* Rothschild (1898, p. 53) is relegated to the synonymy of *N. parvulus parvulus*, in which I follow Snodgrass & Heller (1904, p. 370) and Ridgway (1907, p. 256). *Nesomimus melanotis dierythrus* is also here placed in the synonymy of *parvulus*. One new subspecies is here described, *Nesomimus parvulus wenmani*, from Wenman Island.

Nesomimus is a homogeneous group, obviously nearly related to the mainland genera of Mimidæ, but it is not possible to designate any one form of *Nesomimus* as most closely related to a mainland species, and to trace any course of increasing divergence from this starting point or from any other. With this in mind I can appreciate Ridgway's (1907) logically correct treatment in regarding each form as a separate species, for each is resident in its island habitat, there are no two forms upon any one island, and there is no question of overlapping ranges. I can not bring myself, though, to place such widely different forms as *trifasciatus*, *macdonaldi*, *melanotis*, and *parvulus* on exactly the same basis as the slightly differentiated variants of the *parvulus* group.

Differentiating color characters that have been used in the genus *Nesomimus* pertain to blotches and spots on the breast; color of upper surface and whether streaked or not; white spots on wing coverts and tertials, at tips of primaries and secondaries, at tips of rectrices; relative distinctness of nuchal collar, and of

dusky submalar streak; color of pileum, ear coverts, sides of neck, sides of breast, flanks, and rump. Some of these features, oft-quoted, are really useless in differentiating species and subspecies. Even those of taxonomic significance are variable to such a degree that it is possible to take any one character and trace it from an extreme of development in one species, through various lessening degrees in other species, and finally to where it is present in some individuals and absent in others in subspecies where this character dwindles to the vanishing point. In this sense, all of the forms of *Nesomimus* might be regarded as subspecies of one species. As a matter of fact, there are gaps between certain of the forms that render it perfectly reasonable to recognize them as distinct species, though closely related and distinguished only by the different extent of development of the same characters. On the other hand, on the islands occupied by what I regard as subspecies of *parvulus*, there is in each case individual variation that overlaps every differentiating character that has been adduced as distinguishing any given form from its nearest neighbor and nearest relative (I believe the terms are here equivalent). The extremes, even, are so slightly different that it seems to me perfectly reasonable to treat them all as subspecies, a treatment that is thus admittedly based on intergradation through individual variation and on degree of difference, and disregarding the fact that in these sedentary island forms there can be no actual contact or overlapping of habitats between the different subspecies. Should it be insisted upon that insular isolation implies specific difference between all of the described forms, I can see no reason for not going a step farther and recognizing as specifically different the birds of every island, whether or not their differences are visible to our eyes. In the case of *Nesomimus* there are certain described forms that may be distinguished by any one at a glance, there are others that may be recognized by any intelligent layman after having had the characters pointed out to him, and there are still others that present minute average differences that can be appreciated only by the specialist and by him only after most careful study. Would it be illogical, in still other cases where the birds from different islands are, to our eyes, alike, to assume that their actual separation warrants the same nomenclatural treatment that is adopted in the last mentioned case?

As a matter of fact, of course, we do not feel like giving names to what we cannot define. Hence, in the admittedly difficult matter of the nomenclatural treatment to be afforded island forms, I prefer here to base such treatment upon degree of differences and upon the extent of individual intergradation, regardless of the actual isolation of individuals upon islands. So, in *Nesomimus* I feel able to recognize four rather sharply defined species, with, under one of these species, seven slightly differentiated subspecies.

I do not sympathize with attempts to indicate close relationship between birds on widely separated islands, as has been done, for example, in the lumping together of Wenman and Barrington birds under one name. It can be seen, *reductio ad absurdum*, in the chart published by Beebe (1924, pl. 13, opp. p. 72) showing supposed relationships of the species of *Nesomimus*. That author is not to blame for accepting as he did the explicit statements of those who have studied these birds, but the fact is that the characters forming the basis of this emphatic and startling diagram are by no means the trenchant, conspicuous features that one would naturally suppose them to be. It must be borne in mind that the different forms of *parvulus* are so closely similar in appearance as, in some cases, to be distinguished at all only by the closest scrutiny. Characters used to distinguish them, indicated on the diagram cited, are some of them non-existent, in other cases barely discernible, in still others present or absent in varying degree within series from all the different islands. My material for the most part shows resemblances between neighboring forms, but the relative position of the islands of the Galapagos Archipelago is not such as to suggest any linear arrangement of species and subspecies.

The specimens available in the present study total 790 skins, 660 in the Academy collection, 130 from Stanford University Museum. Besides adults, all of the forms except *hulli* and *wenmani* are represented in juvenal plumage, and the young birds, in general show differences that closely parallel those seen in adults. Young *trifasciatus* is dark colored, extensively spotted below and with the spots on the breast tending to form a blotch on each side. Young *macdonaldi*, compared with young *trifasciatus*, is paler colored and larger, with noticeably long bill; a restricted portion of the breast is spotted and the flanks streaked, throat and abdomen are immaculate: rectrices show scarcely a trace of white tips. Young *melanotis* is pale colored, the spots

below more sparsely scattered than in *trifasciatus* and *macdonaldi*, the rectrices conspicuously white-tipped, the bill small. Young *parvulus* and young *barringtoni* differ as do adults. The former is dark colored, heavily spotted below, except on throat and belly, with short terminal tail spots, and with small bill. Young *barringtoni* (only one specimen available) is pale colored, with small spots on upper breast only, with extensive white tips to the rectrices and with long bill.

It is a difficult matter to trace plumage changes in this series, for there is an almost total lack of molting birds. In juvenal plumage, the one young example of *trifasciatus* was taken on February 26. Of *macdonaldi*, young collected from June 23 to July 2 are full grown and beginning the post-juvenal molt. Of *melanotis*, nestlings were collected on January 25, and full grown young up to February 23. Of *parvulus*, juvenal plumaged birds were taken from March 5 to May 1. The one juvenal specimen of *barringtoni* is dated July 9. It thus appears that *Nesomimus* may be found in juvenal plumage over half the year, on one island or another, and our series shows this plumage on specimens of one form (*parvulus*, from Albemarle) taken over a period of two months. From the degree of wear and fading shown on different specimens taken on the same island, at the same time, it appears that the period of molt in adults is also long drawn out. Of *trifasciatus*, the most worn and faded specimens were taken on October 3, but there are perfectly fresh-plumaged birds in greater number, and one that is molting, that were collected on the same day. The same sort of variation is shown on other of the islands. Apparently *Nesomimus* has one complete molt per year, but the duration of this molt, in different individuals, extends over a long period of time. It seems for the most part to take place in April and May; June and July specimens are the freshest and cleanest. September and October birds, represented by large series, are mostly good clean-plumaged specimens, but, as a rule, without the first bloom of newly acquired feathers. January and February specimens on the average show a more worn condition, and those taken in March and April are among the most shabby. In all the series, though, there is no such uniformity of change and no such limited period of change as are seen in North American birds.

An unfortunate defect in the series lies in the fact that in collecting these birds the "adult" and "immature" stages were

not differentiated as can so easily be done from the character of the skull, sometimes for two months or more after the juvenal plumage is discarded and old and young are outwardly almost alike. It might very well prove to be the case here, as has been demonstrated in other species, that differences ascribed to "individual variation," would yield to an orderly arrangement according to age. The occasional spotting on the breast of forms of *Nesomimus* that are ordinarily immaculate is one character that may be suspected to persist in some immature birds. I find some

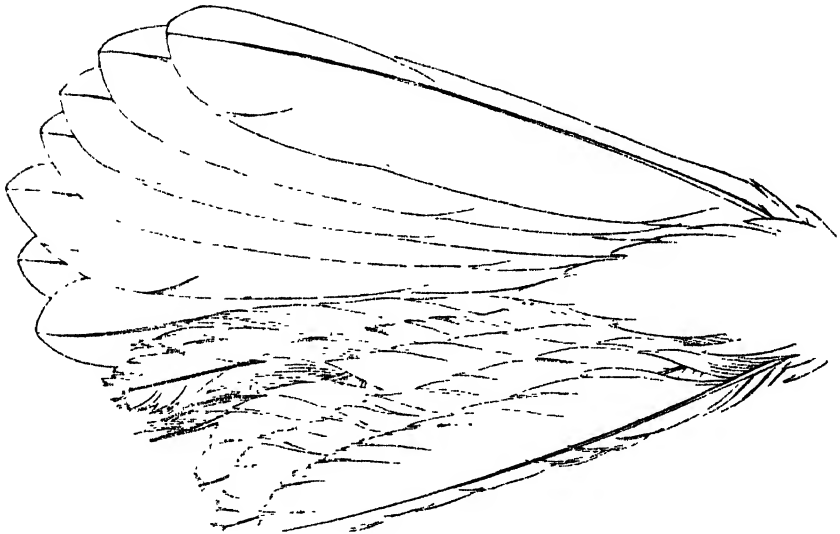


Fig. 11. Tail of *Nesomimus macdonaldi*, showing variation that may be due to age; male, no. 3738; natural size. All of the rectrices on the right side and one on the left appear to have been lost in some way other than by the regular molt. They have been replaced by feathers of greater length and breadth (presumably adult plumage), as compared with the remaining old (presumably immature) feathers on the left side, which are much worn and would soon be molted.

specimens with narrower rectrices than others (see fig. 11) another feature suggesting immaturity. but lacking the clue afforded by positive data regarding skull structure I have not been able to work out any definite order of slightly different plumages.

The accompanying "Key" is not submitted as a means of identifying closely similar subspecies. The different forms of *Nesomimus* are segregated upon different islands, sometimes one species or subspecies upon several islands, but never more than one form

upon any one island. Hence, locality alone is sufficient data for nominal identification. The "Key" aims to present in shape to be readily grasped the features that are used to characterize the birds from the different islands. Overlapping of characters in neighboring subspecies occurs to such an extent as to preclude the possibility of constructing for the identification of these subspecies a "Key" that will serve for every specimen of a given form. Presented in this shape, however, it is easier to grasp the manner of variation that obtains in the genus than it is by means of detailed descriptions that compare, feature by feature, different forms that are variously situated, near to or far from, one another. It should be understood that in the case of closely similar subspecies, distinguished by slight size difference, comparison of females of the larger with males of the smaller subspecies, will result in an apparent overlapping of characters such as will not appear by comparison of specimens all of the same sex.

KEY TO THE SPECIES AND SUBSPECIES OF *Nesomimus*

(Measurements given are of male birds)

- a. Breast marked laterally with brown patches, or crossed by dusky spots, or with partly concealed dusky spots or blotches
 - b. Auricular region usually whitish; breast with a large patch of dusky on each side, median portion with smaller spots extending across; outer rectrices with poorly defined whitish tips.....*Nesomimus trifasciatus*
 - bb. Auricular region dusky.
 - c. Bill larger (culmen 30.2—34.5 mm.); spotting on breast distinct; outer rectrices usually not tipped with whitish*Nesomimus macdonaldi*
 - cc. Bill smaller (culmen 22.2-23.5 mm.); spotting on breast indistinct or obsolete; outer rectrices with sharply defined white tips.*Nesomimus melanotis*
- aa. Breast pure white, usually entirely unmarked
 - b. Bill smaller (culmen 18.2-22.0, usually less than 21 mm.)*Nesomimus parvulus parvulus*
 - bb. Bill larger (culmen usually more than 21 mm.)
 - c. Paler above
 - d. Larger (wing 113.5—118.0 mm.); maxillary streak distinct.....*Nesomimus p. bauri*
 - dd. Smaller (wing 103.5-111.0 mm.); maxillary streak absent or faintly indicated.. ..*Nesomimus p. barringtoni*
 - cc. Darker above
 - e. Wing bars narrower; dorsal coloration extremely dark
 - f. Bill larger (culmen 24.0—26.0 mm.)*Nesomimus p. personatus*
 - ff. Bill smaller (culmen 21.0—24.5 mm.)*Nesomimus p. bindloeii*
 - ee. Wing bars broader: slightly paler dorsally.
 - g. Maxillary streak absent or faintly indicated*Nesomimus p. wenmani*
 - gg. Maxillary streak distinct. .. *Nesomimus p. hulli*

SPECIMENS OF *Nesomimus* IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF
SCIENCES AND (FIGURES IN PARENTHESES) IN THE STANFORD
UNIVERSITY COLLECTION

Name	Island	Male	Female	Young	Sex undetermined
<i>Nesomimus p. hulli</i>	Culpepper	5 (3)	3 (2)		
<i>Nesomimus p. wenmani</i>	Wenman	6	3		
<i>Nesomimus p. personatus</i>	Abingdon	19 (2)	9 (2)	1	
<i>Nesomimus p. bindloei</i>	Bindloe	18 (2)	16 (4)	(2)	
<i>Nesomimus p. bindloei</i>	James	10 (2)	8 (1)	(9)	4
<i>Nesomimus p. bindloei</i>	Jervis	19	12		(3)
<i>Nesomimus p. parvulus</i>	Daphne	1			
<i>Nesomimus p. parvulus</i>	S. Seymour	8 (4)	3 (4)	1 (2)	(1)
<i>Nesomimus p. parvulus</i>	Indefatigable	55 (2)	34 (1)	2	5 (1)
<i>Nesomimus p. parvulus</i>	Albemarle	22 (13)	19 (13)	22 (2)	1
<i>Nesomimus p. parvulus</i>	Narborough	4 (7)	2 (8)		
<i>Nesomimus p. bauri</i>	Tower	12 (1)	7 (5)	(3)	(1)
<i>Nesomimus p. barringtoni</i>	Barrington	54	16	1	2
<i>Nesomimus melanotis</i>	Chatham	69 (3)	55 (1)	4 (2)	5
<i>Nesomimus macdonaldi</i>	Hood	28 (4)	22 (5)	15 (3)	1
<i>Nesomimus macdonaldi</i>	Gardner-near-Hood	7	6		1
<i>Nesomimus trifasciatus</i>	Gardner-near-Charles	14	14		1
<i>Nesomimus trifasciatus</i>	Champion	8	4	1	1

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM) OF SPECIES AND

SUBSPECIES OF *Nesomimus*

MALES

Number of specimens	Name	Island	Wing	Tail	Culmen	Tarsus	Middle toe and claw	White spot on outer rectrix
5	<i>Nesomimus p. bulii</i>	Culpepper	110.9 (109.0-112.5)	99.5 (98.0-101.5)	24.0 (23.5-24.5)	34.5 (33.0-36.2)	25.9 (25.5-26.5)	17.7 (17.0-18.5)
6	<i>Nesomimus p. wennani</i>	Wenman	110.9 (108.2-112.5)	105.1 (95.0-110.0)	23.6 (22.5-24.8)	34.7 (34.0-36.0)	26.0 (25.0-27.0)	19.5 (16.2-22.0)
10	<i>Nesomimus p. personatus</i>	Abingdon	109.6 (105.5-112.5)	101.2 (94.0-109.0)	25.2 (24.0-26.0)	35.9 (34.0-38.0)	25.9 (25.0-27.0)	21.6 (18.0-24.2)
10	<i>Nesomimus p. bindloeii</i>	Bindloe	108.0 (102.2-115.0)	101.1 (93.5-115.0)	23.8 (22.0-24.5)	34.5 (33.0-36.0)	24.8 (23.5-26.2)	20.7 (17.5-22.5)
10	<i>Nesomimus p. bindloeii</i>	James	111.1 (101.0-119.2)	106.0 (95.0-115.2)	22.2 (21.0-23.5)	36.3 (33.8-38.5)	25.8 (24.0-27.0)	21.8 (18.5-24.2)
8	<i>Nesomimus p. bindloeii</i>	Jervis	109.4 (104.0-112.8)	105.8 (98.5-111.2)	22.9 (22.0-24.5)	35.3 (35.0-36.0)	24.8 (24.0-25.2)	20.3 (16.0-22.5)
10	<i>Nesomimus p. parvulus</i>	S. Seymour	110.2 (108.0-112.8)	105.3 (100.0-110.0)	21.5 (21.0-22.0)	35.3 (34.5-37.0)	25.6 (24.8-26.2)	21.8 (19.5-24.5)
10	<i>Nesomimus p. parvulus</i>	Indefatigable	108.5 (100.0-115.5)	104.0 (90.2-117.0)	20.3 (19.6-21.2)	35.6 (33.0-37.0)	25.1 (24.0-26.0)	23.0 (17.0-23.0)
3	<i>Nesomimus p. parvulus</i>	Albemarle	110.3 (107.5-115.5)	107.6 (102.0-115.0)	19.9 (19.0-21.0)	37.3 (35.6-39.0)	25.0 (23.5-26.8)	20.5 (17.0-23.5)
10	<i>Nesomimus p. parvulus</i>	Narborough	108.0 (102.5-112.5)	101.7 (98.0-104.2)	19.1 (18.2-20.0)	34.7 (34.2-35.0)	23.8 (23.5-24.5)	16.1 (15.0-18.2)
10	<i>Nesomimus p. bauri</i>	Tower	115.7 (113.5-118.0)	107.7 (99.0-111.6)	26.2 (24.0-27.5)	35.8 (35.0-36.5)	25.3 (24.0-26.2)	20.6 (17.5-22.2)
10	<i>Nesomimus p. barringtoni</i>	Barrington	109.1 (103.5-111.0)	106.7 (100.0-110.0)	26.0 (25.2-26.5)	34.1 (32.1-35.2)	24.3 (23.2-25.0)	24.1 (22.0-27.0)
10	<i>Nesomimus melanotis</i>	Chatham	111.7 (109.0-117.0)	103.3 (96.5-110.2)	23.0 (22.2-23.5)	38.0 (37.0-40.0)	26.8 (26.0-27.2)	22.9 (18.0-25.5)
10	<i>Nesomimus macdonaldi</i>	Hood	124.0 (121.0-127.0)	113.9 (112.0-116.5)	32.8 (30.2-34.5)	38.6 (38.0-39.0)	28.7 (28.0-30.0)	
7	<i>Nesomimus macdonaldi</i>	Gardner-near-Hood	121.8 (118.0-122.5)	111.9 (110.0-114.5)	31.9 (31.2-32.5)	37.3 (35.0-38.5)	27.3 (26.5-28.0)	
10	<i>Nesomimus trifasciatus</i>	Gardner-near-Charles	123.2 (118.5-126.0)	113.8 (106.0-120.5)	27.7 (25.5-29.5)	40.3 (39.5-42.0)	27.6 (26.5-28.5)	
8	<i>Nesomimus trifasciatus</i>	Champion	121.1 (117.0-125.0)	112.1 (107.0-116.0)	26.6 (25.5-27.5)	40.3 (40.0-42.0)	27.4 (27.0-28.0)	

FEMALES

5	<i>Nesomimus p. bulii</i>	Culpepper	103.4 (101.5-104.5)	92.9 (91.5-94.5)	23.9 (22.5-24.8)	33.6 (32.0-35.0)	24.7 (23.0-25.2)	15.6 (14.0-17.0)
3	<i>Nesomimus p. wennani</i>	Wenman	101.9 (98.2-104.5)	95.2 (90.0-100.0)	23.5 (22.2-25.0)	33.3 (32.5-34.5)	24.1 (23.5-24.5)	18.4 (16.8-21.0)
10	<i>Nesomimus p. personatus</i>	Abingdon	102.1 (100.0-104.2)	95.4 (88.0-103.0)	24.4 (23.5-25.2)	34.7 (33.5-36.2)	24.5 (23.2-25.5)	21.8 (20.0-23.0)
10	<i>Nesomimus p. bindloeii</i>	Bindloe	101.1 (97.5-106.5)	95.0 (89.0-100.5)	23.1 (22.2-24.0)	33.2 (31.2-36.3)	23.3 (21.8-26.0)	20.4 (17.0-23.0)
9	<i>Nesomimus p. bindloeii</i>	James	104.3 (96.5-110.0)	99.1 (94.0-106.0)	22.8 (21.8-24.5)	35.2 (33.4-37.0)	24.3 (23.0-26.5)	19.3 (15.0-22.0)
10	<i>Nesomimus p. parvulus</i>	Jervis	100.3 (96.5-105.0)	94.8 (91.0-99.5)	22.4 (22.0-22.0)	33.5 (32.2-34.8)	23.7 (22.5-25.0)	18.9 (14.0-22.0)
7	<i>Nesomimus p. parvulus</i>	S. Seymour	102.1 (101.0-104.2)	96.0 (92.0-101.0)	21.0 (20.0-22.0)	34.1 (33.0-35.5)	24.0 (23.5-25.0)	20.9 (20.0-22.0)
10	<i>Nesomimus p. parvulus</i>	Indefatigable	102.3 (97.2-111.0)	98.1 (91.5-108.5)	21.0 (20.0-23.0)	34.5 (34.2-37.0)	24.2 (23.0-26.2)	17.5 (14.2-20.0)
10	<i>Nesomimus p. parvulus</i>	Albemarle	101.5 (97.2-104.2)	96.0 (89.2-102.0)	20.1 (19.0-21.0)	35.5 (34.2-37.0)	23.4 (23.0-25.0)	18.9 (14.0-17.5)
10	<i>Nesomimus p. parvulus</i>	Narborough	100.7 (96.5-105.5)	95.0 (87.5-106.5)	25.1 (24.5-27.0)	34.1 (33.5-35.0)	23.4 (21.5-24.8)	15.7 (17.0-20.5)
10	<i>Nesomimus p. bauri</i>	Tower	109.0 (105.0-110.5)	102.6 (93.5-106.5)	26.1 (24.5-27.0)	34.1 (33.5-35.0)	23.9 (22.0-25.0)	18.7 (17.0-20.5)
10	<i>Nesomimus p. barringtoni</i>	Barrington	104.1 (100.0-109.5)	100.5 (97.2-103.2)	22.5 (22.5-23.5)	33.9 (31.4-34.3)	23.7 (22.0-25.0)	23.4 (20.0-26.0)
10	<i>Nesomimus melanotis</i>	Chatham	114.3 (112.5-117.5)	102.0 (95.0-106.0)	29.0 (21.0-32.0)	36.2 (35.5-38.5)	24.2 (22.2-26.0)	20.7 (19.0-24.0)
10	<i>Nesomimus macdonaldi</i>	Hood	114.3 (112.5-117.5)	102.0 (95.0-106.0)	30.4 (23.0-32.0)	38.1 (35.0-37.0)	26.9 (26.2-28.0)	
6	<i>Nesomimus macdonaldi</i>	Gardner-near-Hood	112.6 (110.0-115.5)	99.4 (94.5-103.5)	30.3 (29.8-31.5)	36.7 (36.0-37.5)	25.8 (25.0-26.8)	
10	<i>Nesomimus trifasciatus</i>	Gardner-near-Charles	117.8 (114.0-121.0)	110.9 (101.5-115.0)	27.1 (25.5-28.0)	38.4 (37.0-40.0)	26.2 (24.5-28.0)	
3	<i>Nesomimus trifasciatus</i>	Champion	112.3 (111.0-114.0)	98.7 (93.0-99.5)	25.7 (25.6-26.0)	38.7 (38.2-39.5)	25.7 (25.5-26.0)	

60. *Nesomimus trifasciatus* (Gould)

Orpheus trifasciatus Gould, 1837d, p. 27 (orig. descr.; "from the Galapagos").

Mimus trifasciatus Gray, 1841 (= Nov., 1839), p. 62, pl. 16 (Charles Id.).—Sclater, 1859, p. 345.—Salvin, 1876, p. 471.—Sharpe, 1881, p. 346.

Nesomimus trifasciatus Ridgway, 1897, p. 483; 1907, p. 247.—Rothschild & Hartert, 1899, p. 143.—Snodgrass & Heller, 1904, p. 358.

ORPHEUS TRIFASCIATUS Gould*

Cotype.—British Museum, no. 38.2.21.401; ad., sex?; Galapagos.

Cotype.—British Museum, no. 55.12.19.225; ad., sex?; Galapagos; Darwin.

HABITAT.—Formerly on Charles Island, where it now appears to be extinct; Gardner Island, near Charles; Champion Island, near Charles.

There are at hand 43 specimens in the Academy collection (nos. 3661-3703), collected on Gardner-near-Charles, October 3, 1905, and on Champion, October 3, 1905, and February 26, 1906.

As regards the three southernmost forms, *trifasciatus*, *macdonaldi*, and *melanotis*, there has been general acceptance of their standing as distinct species. *Trifasciatus* (from Charles Island and adjoining islets) is set apart by many trenchant characters of color and markings, among which may be mentioned dark brown coloration, unstreaked upper surface, whitish auricular region, patches of dusky at sides of breast, and, according to previous writers, dark brown iris. Of variants of these characters, the auricular region mostly whitish as a rule, is often streaked with dusky and in some instances is mostly dusky. From the dusky pectoral patches disconnected spots tend to form two lines across the breast; occasionally this is varied by round spots evenly spread over the same area, much as in young birds. Dusky submalar streaks, generally well marked, are sometimes barely indicated. Mostly solid brown above, some fresh plumaged birds do show, in paler margins to dark-colored dorsal feathers, a slight approach toward the streaked condition of the other forms.

Most of the birds collected on October 3 are in relatively unworn plumage, but curiously enough, there are a few taken the same day, in which wear and fading have proceeded to such a

*Data given above were copied by myself from the labels of the two specimens. Mr. Kinnear gives me another version, from Museum registers, as follows:
British Museum, no. 37.2.21.401; ♂ ad.; Charles Island; Burnett and Fitzroy.
Type.—British Museum, no. 55.12.19.225; ad., sex?; Charles Island; Darwin;
cx Zoological Society's collection.

degree as to have nearly obliterated all distinctive features of color and markings. Those taken on February 26 are mostly rather badly worn, and presumably the annual molt would begin very shortly thereafter. The one young bird collected, taken February 26, is in juvenal plumage throughout, with wing and tail feathers full grown. Throat and breast are spotted, flanks streaked, and of the lower surface only the center of the abdomen and the lower tail coverts are unmarked. There is a tendency for the spots at the sides of the breast to coalesce into large blotches, as in the adult, and higher up the spots run together to form a line across the throat, a feature that is indicated, too, in

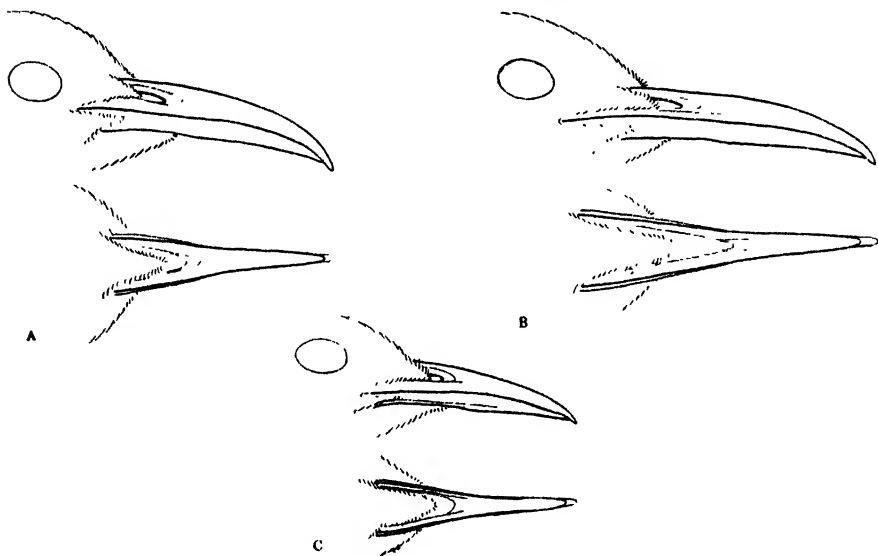


Fig. 12. a, *Nesomimus trifasciatus*, male (no. 3699), Gardner-near-Charles; b, *Nesomimus macdonaldi*, male (no. 3738), Hood; c, *Nesomimus melanotis*, male (no. 3802), Chatham. Natural size.

several adults. The juvenal rectrices are appreciably shorter and narrower than in the adult. A male bird collected on October 3 (no. 3677) is spotted below almost as extensively as the juvenile just described, and dorsally the two are closely similar also, but abrasion of the feathers on this bird is such as to show that the plumage had been worn many months, and the tail feathers are as in the adult. Several other specimens show spotting on the breast to a greater or less extent.

This series does not exhibit the transverse white markings on pileum and back used by Ridgway (1907, p. 245) in his "key to

the species of *Nesomimus*." In one or two birds there is an indication of light edgings to feathers on the pileum, and in several

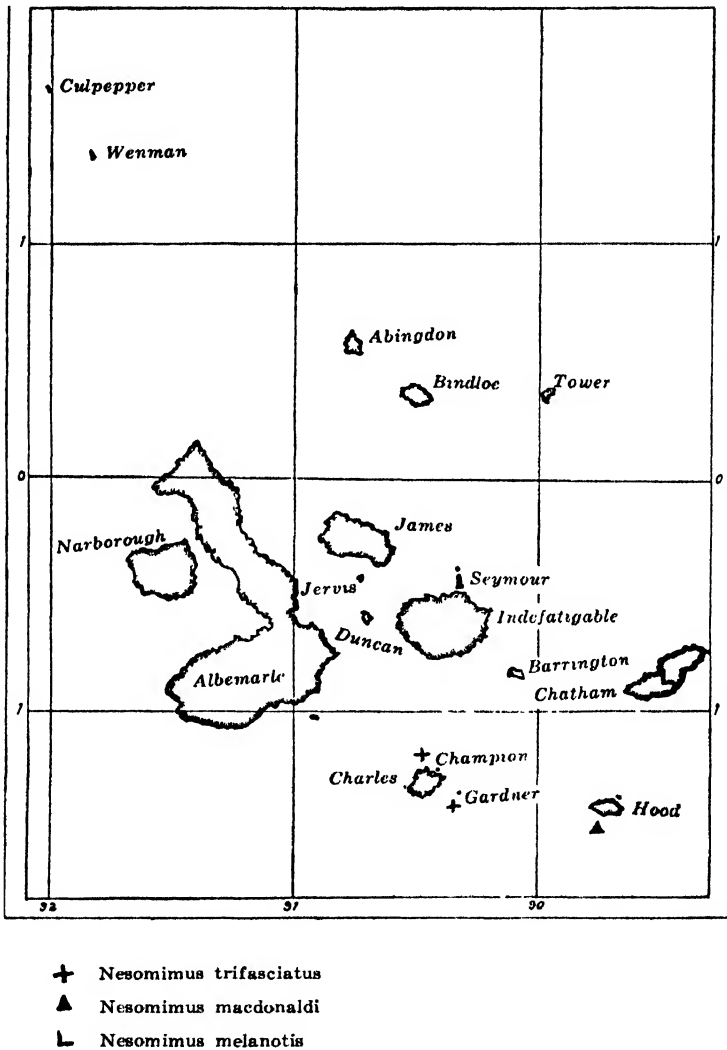


Fig. 13. Map showing present distribution of *Nesomimus trifasciatus*, *N. macdonaldi*, and *N. melanotis*. Symbols indicate islands where recorded.

others there are white feathers in various amount scattered over the entire crown. This tendency culminates in one bird which has

the top of the head mostly white, continuous with the white ear coverts. Rothschild & Hartert (1899, p. 143) mention a specimen with white feathers on the pileum.

Birds from Champion Island average slightly smaller in length of wing, tail and culmen, than those from Gardner (see table, p. 113) but I can not distinguish any difference in color and markings. None of the Champion Island birds, however, exhibits any white markings on the pileum.

It has been assumed without question that Darwin's types came from Charles Island, but while that may have been the case there is no positive evidence to that effect in any of his writings. Gardner Island, near Charles, was visited, if not by Darwin, by others from the *Beagle*, and upon Gardner as well as Champion the species has been found by subsequent visitors. I am informed by Mr. Joseph Slevin, Curator of Herpetology in this Academy (who has twice visited the Galapagos) that the northern coast of Charles, adjacent to Champion, at the time of his visit was not inhabited by dogs and cats (supposedly the exterminators of *Nesomimus* upon Charles), and there seems to be no reason why the mockingbirds should not have re-established themselves there. At any rate, their absence from that coast implies extremely sedentary habits, for Champion is not more than three quarters of a mile off shore. The Academy party in thirty-three days of collecting found none of the species upon Charles. There are other islands in the archipelago inhabited by dogs and cats where the mockingbirds have not disappeared.

61. *Nesomimus macdonaldi* Ridgway

Nesomimus macdonaldi Ridgway, 1890, p. 103 (orig. descr.; Hood Id.); 1897, p. 484; 1907, p. 248.—Rothschild & Hartert, 1899, p. 143; 1902, p. 381.—Snodgrass & Heller, 1904, p. 359.

NESOMIMUS MACDONALDI Ridgway

Type.—United States National Museum, no. 116066; ♂ ad.; Hood Island; April 7 (1888); U. S. Fish Commission, Voyage of Albatross, 1887-88.

HABITAT.—Hood Island and Gardner Island near Hood.

There are at hand 80 specimens in the Academy collection (nos. 3704-3783): Hood Island, September 25, 27 (1905), ten; October 2, fifteen; January 28, 31 (1906), two; February 1, 5, sixteen;

June 23, 28, 30, twenty-one; July 2, two. Gardner-near-Hood, September 28, 29, 30 (1905), twelve; February 3 (1906), one; June 27, one. From Stanford University Museum, 12 specimens, collected on Hood Island, May 13-18, 1899.

Macdonaldi, from Hood Island, east of Charles, is distinguished from all other species and subspecies by greater length of culmen. *Trifasciatus*, averaging smaller in this respect, approaches it closely in measurements of one or two individuals, but there is no actual overlapping in our series. *Trifasciatus* and *macdonaldi* are both appreciably larger in general size than any of the other forms, as reflected in length of wing and tail (see table of measurements). In coloration *macdonaldi* is grayish, streaked above; the auriculars are usually dusky, though sometimes mixed with whitish, just as in some examples of *trifasciatus*. The pectoral blotches, boldly exposed in *trifasciatus*, are in *macdonaldi* partly concealed under the feathers, though the area covered is plainly discernible, outlined by disconnected spots. Here again some adults are spotted entirely across the breast, somewhat as in the young. In the juvenal plumage the breast is heavily spotted, the flanks streaked, throat and abdomen immaculate; rectrices show hardly a trace of white tips. *Macdonaldi* has the least white spotting at the end of the rectrices of any form of the genus. In most cases these markings are almost entirely absent, in none are they sharply defined.

According to Gifford (1919, p. 209) the nesting season is mostly in February, when he found nests and eggs, but it must begin much earlier as there is a spotted young one in the series taken on January 28. Others in juvenal plumage were collected during the last two weeks in June and on July 2. As with the post-juvenal molt, the annual molt appears to be accomplished by different individuals over a long period of time. Birds exhibiting the last degree of feather wear and fading, were collected in February and in September, and fresh plumaged birds on practically the same dates. Molting adults were collected during June.

62. *Nesomimus melanotis* Gould

Orpheus melanotis Gould, 1837d, p. 27 (orig descr.; "from the Galapagos").

Mimus melanotis Gray, in Gould, 1841 (= Nov., 1839), p. 62, part, pl. 17 (Chatham).—Sclater, 1859, p. 345, part.—Sundevall, 1871, p. 124, part.

Nesomimus melanotis Ridgway, 1890, p. 102, part.

Nesomimus adamsi Ridgway, 1894, p. 358 (orig. descr.; Chatham Id.); 1897, p. 485; 1907, p. 249.—Rothschild & Hartert, 1899, p. 144; 1902, p. 381.—Snodgrass & Heller, 1904, p. 360.—Gifford, 1919, p. 210 (habits).—Hartert, 1920, p. 478 (particulars of type specimen, in Rothschild Museum).

ORPHEUS MELANOTIS Gould

**Cotype*.—British Museum; ad., sex? Evidently a "Beagle" specimen, but with no data. Specimen "b" of the Catalogue of Birds (vol. 6, p. 350).

NESOMIMUS ADAMSI Ridgway

Type.—Rothschild Museum; ♂ ad.; Chatham Island; June 13, 1891; Dr. G. Baur; orig. no. 694.

HABITAT.—Chatham Island.

One hundred and thirty-three specimens in the Academy collection (nos. 3784-3916), as follows: September 8, 10 (1905), twenty-six; October 16-18, thirty-three; January 25-29 (1906), nine; February 8-23, thirty-six; July 5-7, twenty-nine.

Careful reading of the description of *Orpheus melanotis* Gould (1837d, p. 27), and inspection of the plate (Gould, 1841, pl. 17) shows that the species treated under that name is the Chatham Island mockingbird and not the James Island bird, as has been generally assumed. Darwin ascribed the species to Chatham and James. In the British Museum I found two specimens in the "*melanotis*" series that came from the Beagle collection. One of these, specimen "a" of the Catalogue of Birds (vol. VI, p. 350), where it is entered as the type of the species, is a James Island bird. The other, specimen "b" of the same Catalogue, is of the Chatham Island species, with no exact data but obviously a "Beagle" specimen. Both birds had been mounted, and had been dismounted at the same time, from memoranda upon their labels. The important thing is that specimen "b" accords closely with Gould's description and plate of *melanotis*. Both the malar stripe and breast markings appear in the illustration, characters of the Chatham Island bird but not of the James Island species. These plates are supposed to be the exact size of the birds figured, and specimen "b" complies with this test perfectly (in bill measurement, for example), as specimen "a" does not. Altogether, it seems

*"I have found another specimen of the Chatham Island bird of Darwin's collecting, purchased by Eyton from the Zoological Society, and by us after his death. It is labeled by Eyton as *parvulus*. Reg. no. 81.2.18.80; Galapagos; C. Darwin." N.B.K.

obvious to me that Gould's description and illustration of *Orpheus melanotis* pertain to the Chatham Island mockingbird, and there is little doubt in my mind that specimen "b" above referred to is the actual bird that he had in hand and that his artist copied.

Restriction of the name *melanotis* to the Chatham Island bird leaves *Orpheus parvulus* Gould (1837d, p. 27), described from Albemarle, available as a specific name for the form occurring upon the northern and central islands. The James Island subspecies, to which the name *melanotis* has generally been applied, becomes *Nesomimus parvulus bindloei* (see p. 126).

Our series contains spotted young (nestlings) collected January 25, and full grown young February 22 and 23. None of the birds in this large series is in as badly worn plumage as are some from other islands. The most worn and faded specimens were taken during the third week in February, and July skins evidently represent the species at its best. Variation in this form is most evident in breast markings. Ordinarily the white breast is crossed by two shadowy bands, a mere indication of the dark markings that are so conspicuous on *trifasciatus* and *macdonaldi*. This condition varies, in the one direction, to almost purely white-breasted birds that are with difficulty to be distinguished in color from *bauri* of Hood Island, in the other to birds that have across the breast partly concealed dusky blotches practically as in *macdonaldi*, or else a broad band of smaller spots. Dorsally there is a little darkening with wear, freshly grown feathers having rather broad, light-colored margins that later on disappear in part or altogether. Fresh plumaged birds have practically no indication of a nuchal collar; with wear this feature becomes slightly apparent. Some of the observed variation, especially in breast marking, may be due to age. It may be that the more heavily spotted birds are in the plumage following the post-juvenal molt, the white-breasted birds in their second year or older, but this can not be ascertained from the data at hand.

Melanotis is in size and general appearance more nearly like the forms of *parvulus* on the islands north and west of Chatham, than like *trifasciatus* and *macdonaldi*, from the nearest islands to the south and southwest. It retains, however, distinct traces of the pectoral markings of the latter two species.

63. *Nesomimus parvulus parvulus* (Gould)

Orpheus parvulus Gould, 1837d, p. 27 (orig. descr.; "from the Galapagos").

- Mimus parvulus* Gray, in Gould, 1841 (= Nov., 1839, p. 63, pl. 18 (Albemarle).—Sclater, 1859, p. 345.—Salvin, 1876, p. 472.—Sharpe, 1877, p. 65; 1888, p. 350.
- Nesomimus parvulus* Ridgway, 1890, p. 102; 1897, p. 491; 1907, p. 256.—Rothschild & Hartert, 1902, p. 383.
- Nesomimus parvulus parvulus* Rothschild & Hartert, 1899, p. 146.
- Nesomimus melanotis parvulus* Snodgrass & Heller, 1904, p. 370 (Albemarle and Narborough).
- Nesomimus affinis* Rothschild, 1898a, p. liii (orig. descr.; Narborough Id.).—Hartert, 1920, p. 478 (particulars of type specimen, in Rothschild Museum).
- Nesomimus parvulus affinis* Rothschild & Hartert, 1899, p. 146.
- Nesomimus melanotis* Ridgway, 1890, p. 102, part; 1897, p. 489, part; 1907, p. 253, part.—Gifford, 1919, p. 212, part (habits).
- Nesomimus melanotis melanotis* Rothschild & Hartert, 1899, p. 145, part; 1902, p. 382.
- Mimus melanotis* Sclater & Salvin, 1870, p. 323, part.—Sundevall, 1871, pp. 124, 126, part.—Salvin, 1876, p. 471, part.
- Nesomimus melanotis dierythrus* Heller & Snodgrass, 1901, p. 74 (orig. descr.; Seymour Id.).—Snodgrass & Heller, 1904, p. 367 (Indefatigable and the Seymours).
- Nesomimus dierythrus* Ridgway, 1907, p. 254.

ORPHEUS PARVULUS Gould

Type.—British Museum, no. 55.12.19.93; ad., sex?; Albemarle Island; no date.

NESOMIMUS AFFINIS Rothschild

Type.—Rothschild Museum; ♂ ad.; Narborough Island; December 6, 1897; R. H. Beck (Webster-Harris expedition); orig. no. 2852.

NESOMIMUS MELANOTIS DIERYTHRUS Heller & Snodgrass

Type.—Leland Stanford Junior University, no. 4565; ♂ ad.; North Seymour Island (near Indefatigable); April 27, 1899; R. E. Snodgrass and E. Heller (Hopkins-Stanford Galapagos expedition); orig. no. 240.

HABITAT.—Albemarle, Narborough, and Indefatigable islands, the Seymour Islands (adjoining Indefatigable), Daphne Island, and perhaps Duncan Island.

One hundred and seventy-nine specimens*, as follows: Albemarle: October 31 (1905), three; November 1-3, thirteen; March 5-30 (1906), thirty-two; April 2, 12, 26, three; May 1-2, two;

*Specimens from Albemarle, Narborough, Indefatigable and adjoining islets, Jervis, and James, are catalogued, mixed together, under the following numbers: 3947-4104, 4251-4820.

August 11, 23, 24, 30, ten; September 3, one. Narborough: April 18, 1906, six. Indefatigable: October 25, 27, 28 (1905), eight;

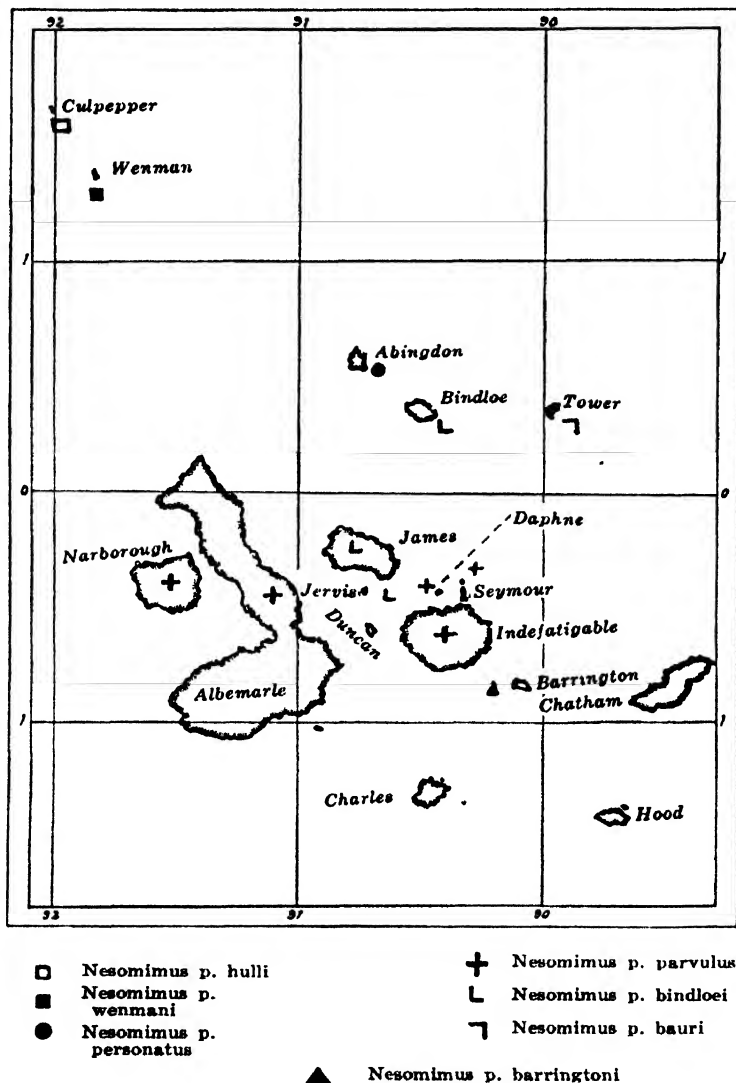


Fig. 14. Map showing distribution of subspecies of *Nesomimus parvulus*. Symbols indicate islands where recorded.

November 6-25, fifty-six; January 11-13 (1906), ten; July 11-24, twenty-two. Daphne (near Indefatigable): July 25 (1906), one.

South Seymour (near Indefatigable): November 21-22 (1905), seven; July 26 (1906), five.

There is but little question as to the propriety of recognizing as distinct species the three southernmost forms, *trifasciatus*, *macdonaldi*, and *melanotis*, but as regards the more northern forms, which I regard as all subspecies of *Nesomimus parvulus*, there have been about as many opinions as there are writers. I have already stated my objection to using a separate specific name for each island race. Snodgrass & Heller divided the forms that I am lumping under *parvulus* into two species, *Nesomimus personatus* and *N. melanotis*. "Along one line [*personatus*] the dark maxillary stripes have been retained and the back has taken on a dusky rather than a brown tone; along the other [*melanotis*] the brown tone of the back has been retained but the maxillary stripes are lost. The first branch includes the races inhabiting Tower, Abingdon, Bindloe and Culpepper; the second those races inhabiting Indefatigable. Barrington, Wenman, James, Albemarle and Narboro" (Snodgrass & Heller, 1904, pp. 361-362). I find myself utterly unable to distinguish the brown backed and black backed races thus differentiated and later described in detail in the report cited. In the series used by Snodgrass & Heller, now before me, such differences as appear in dorsal coloration, are, it seems to me, the effects of different degrees of wear and fading. Careful comparison of larger series, mostly in excellent plumage, both in mass effect and by individual specimens, does not, to my eye, disclose one iota of difference in this respect. As to the maxillary stripes, they form an extremely variable character, more evident on birds from some islands than on those from others but present or slightly indicated on some specimens of each series. I am, for these reasons, disregarding Snodgrass & Heller's major division of these forms.

Our six specimens from Narborough, representing the form *affinis* (Rothschild, 1898, p. liii), are in such worn and faded plumage as to be useless for color comparison. The more satisfactory series of fifteen skins from the Stanford University collection, however, enables me to corroborate Snodgrass & Heller (1904, p. 370; their findings based upon the same material) and Ridgway (1907, p. 256), in treating *affinis* as a synonym of *parvulus*.

The Indefatigable series at hand consists of birds in adult plumage, except one (taken July 13) that still shows a few juvenal

feathers. On several specimens, perhaps not fully adult, there are clusters of small spots on each side of the breast. The Albemarle series includes a number of spotted young, collected on dates ranging from March 5 to May 1.

The outstanding feature of *parvulus* is the small bill (see table of measurements), which serves sufficiently well to distinguish it from other nearly related subspecies. Although included by Snodgrass & Heller in those forms that lack maxillary stripes, I find these marks occasionally present in slight degree.

I am unable to distinguish the Indefatigable bird (*Nesomimus melanotis dierythrus* Heller & Snodgrass) from *parvulus* of Albe-

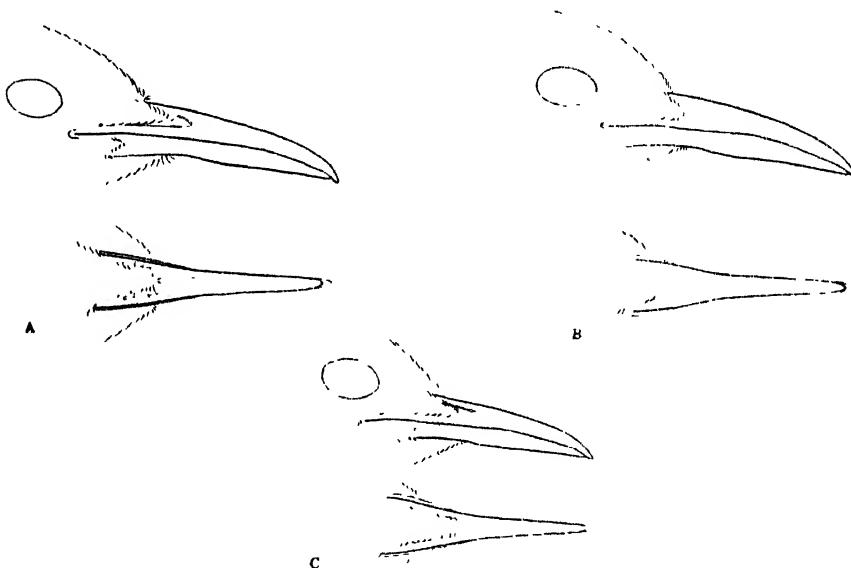


Fig. 15. a, *Nesomimus parvulus bauri*, male (no. 4211), Tower; b, *N. p. barringtoni*, male (no. 4118), Barrington; c, *N. p. parvulus*, male (no. 4295), Albemarle. Natural size.

marle Island. In the original description (Heller & Snodgrass, 1901, p. 74) *dierythrus* is compared with "*melanotis*" (James Island), in a later paper (Snodgrass & Heller, 1904, p. 367) with "*adamsi*" (Chatham Island). There is also the statement (*loc. cit.*, p. 370) that "*melanotis*" is intermediate in character between *dierythrus* and *parvulus*. The Academy series includes 64 skins from Albemarle, and 96 from Indefatigable, and I cannot, on the closest scrutiny, discover any character of color or markings to

distinguish between the two lots. In measurements, also, they are essentially alike (see table, p. 113). Heller & Snodgrass (1904, p. 367) state that *dierythrus* differs from "*adamsi*" "in never possessing any trace of maxillary stripes." There are specimens in our series that possess traces of such stripes, about as apparent as in some examples of *bauri*.

Twelve specimens from South Seymour (a tiny islet barely separated from Indefatigable at its northern extremity) are indistinguishable from the Indefatigable series. A male from Daphne (somewhat farther out) is darker than the average of *parvulus*, and with culmen (21 mm.) at the maximum of that form. Gifford (MS) saw a single *Nesomimus* on Duncan Island (midway between Indefatigable and Albemarle) on August 14, 1906. This was not during the breeding season, and sufficient time was spent on Duncan (December 1 to 17, 1905; August 14 to 16, 1906) to justify the conclusion that the species is of no more than occasional occurrence there. Rothschild & Hartert (1899, p. 115) comment upon the absence of *Nesomimus* from Duncan.

61. *Nesomimus parvulus barringtoni* Rothschild

Nesomimus carringtoni (typographical error, = *barringtoni*) Rothschild, 1898b, p. vii (orig. descr.; Barrington Island).—Hartert, 1920, p. 478 (particulars of type specimen, in Rothschild Museum).

Nesomimus melanotis carringtoni (sic) Rothschild & Hartert, 1899, p. 145.

Nesomimus melanotis barringtoni Snodgrass & Heller, 1904, p. 368, part (Barrington Island).

Nesomimus barringtoni Ridgway, 1907, p. 256, part (Barrington Island).

Nesomimus melanotis Gifford, 1919, p. 212, part (habits).

NESOMIMUS BARRINGTONI Rothschild

Type.—Rothschild Museum: ♂ ad.: Barrington Island: July 10, 1897; R. H. Beck (Webster-Harris expedition): orig. no. 1510.

HABITAT.—Barrington Island.

Seventy-three specimens, all from Barrington Island, as follows: October 20-24 (1905), sixty-three; July 9-10 (1906), ten. (C. A. S. nos. 1105-1176, 4186.) The series includes one spotted juvenile, full-grown as to size, collected on July 9.

Barringtoni (on Barrington Island) and *bauri* (Tower Island) are alike in general coloration, being relatively grayish-backed

(*bauri* slightly more so than *barringtoni*), and paler than the remaining *parvulus* subspecies. They are on islands that are widely separated north and south, but both of them east of the islands occupied by the other subspecies. The differences between *barringtoni* and *bauri* resolve themselves into the following: a slight difference of shade in dorsal coloration; wing length (103.5—111.0 mm. in *barringtoni*, 113.5—118.0 in *bauri*); length of terminal white spot on rectrices (22.0—27.0 mm. in *barringtoni*, 17.5—22.2 in *bauri*).

65. *Nesomimus parvulus bindloei* Ridgway

Nesomimus bindloei Ridgway, 1894, p. 358 (orig. descr.; Bindloe Id.); 1897, p. 492; 1907, p. 251.—Hartert, 1920, p. 478 (particulars of type specimen, in Rothschild Museum).

Nesomimus melanotis bindloei Rothschild & Hartert, 1899, p. 146; 1902, p. 383.

Nesomimus personatus bindloei Snodgrass & Heller, 1904, p. 365.

Mimus melanotis Gray, in Gould, 1841 (= Nov., 1839), p. 62, part.—Sclater, 1859, p. 345, part (James).—Sclater & Salvin, 1870, p. 323, part.—Sundevall, 1871, p. 124, part (James).—Salvin, 1876, p. 471, part.—Sharpe, 1881, p. 349, part.

Nesomimus melanotis Ridgway, 1890, p. 102, part; 1897, p. 489, part; 1907, p. 253.—Gifford, 1919, p. 212, part.

Nesomimus melanotis melanotis Rothschild & Hartert, 1899, p. 145, part; 1902, p. 382, part.—Snodgrass & Heller, 1904, p. 369.

NESOMIMUS BINDLOEI Ridgway

Cotype.—Rothschild Museum; ♂ ad.; Bindloe Island: September 5, 1891; Dr. G. Baur; orig. no. 690.

Cotype.—Rothschild Museum: ♀ ad.; Bindloe Island: September 5, 1891; Dr. G. Baur; orig. no. 691.

Cotype.—Rothschild Museum; ♂ (im.?): Bindloe Island. September 5, 1891; Dr. G. Baur; orig. no. 692.

There are five more skins in the same series in the Rothschild Museum, one collected September 4, four on September 5, all made up "ex spirits." Ridgway did not indicate any particular one as the type, merely mentioning "five specimens," but no. 690 now bears red "type labels" both from the Rothschild Museum and the United States National Museum, showing that Ridgway had so distinguished it before it passed out of his hands.

The ascription of the name *Orpheus melanotis* Gould to the Chatham Island mockingbird entails a change in the nomenclature of the James Island race, entitled *melanotis* in most of the litera-

ture. That form occurs upon James, Jervis and Bindloe islands without variation, so far as I can see. Ridgway (1894, p. 358) described *Nesomimus bindloei* as peculiar to Bindloe Island, but in view of the similarity of birds from the three islands mentioned, that name (apparently the only one available) should be used to cover this whole aggregation.

HABITAT.—James, Jervis and Bindloe islands.

Eighty-four specimens, as follows: Jervis: December 18-21 (1905), thirty-one. James: December 19-23 (1905), eleven; January 2-4 (1906), three; July 30-31, four. Bindloe: September 17-18 (1906), thirty-seven (C. A. S. nos. 4214-4250).

In the subspecies *bindloei*, *personatus*, *wenmani*, and *hulli* the differences are of the slightest and they are average differences that are not to be supposed to hold good in extreme degree in

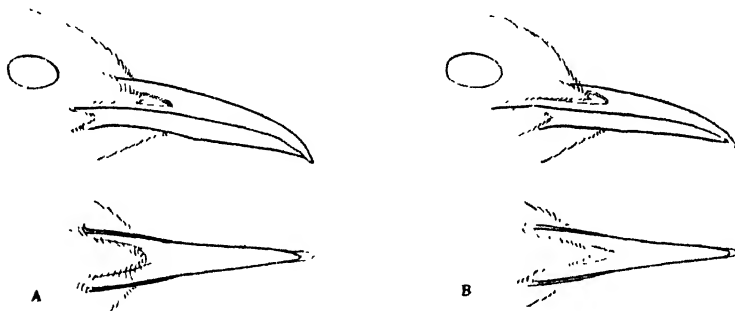


Fig. 16. a, *Nesomimus parvulus personatus*, male (no. 3926), Abingdon; b, *N. p. bindloei*, male (no. 4045), James. Natural size.

every specimen examined. A division may be made of, on the one hand, *bindloei* and *personatus*, with relatively darker back and narrower wing bars, on the other, *wenmani* and *hulli* with relatively less dark back and broader wing bars. *Bindloei* and *personatus* are the darkest of the northern races. The darkest specimen of *bindloei*, from James Island, is quite as dark colored and with as little sign of dorsal streaks as any specimen of *trifasciatus*.

Although *personatus* (Abingdon Island). and "*melanotis*" (James Island), were selected by Snodgrass & Heller as typifying two distinct "series", each including several subspecies, they are to my eye so nearly alike as to barely justify subspecific distinction.

An average difference in culmen measurement is all that I can see. Color differences ascribed fall down utterly; they seem to me to be due entirely to varying degrees of wear and fading. In the original description of *bindloei* and in later publications (by Ridgway, by Rothschild & Hartert, and by Snodgrass & Heller) comparisons are made with *bauri*, and the differences there are obvious enough, but in the series of Bindloe Island birds at hand I fail to discern even the slightest character separating them from the birds of James and Jervis islands. Ridgway (1907, pp. 245-246), in his "key to the species of *Nesomimus*," separates *bindloei* from the other species with unmarked breast by its "distinctly rufescent" rump, in which he follows Rothschild & Hartert (1899, pp. 146-147), who use this character similarly. With every desire to adopt this division of species, I find myself unable to appreciate this feature in the slightest degree. In the series before me from each of the three islands, Jervis, James, and Bindloe, there are some specimens with the rump slightly more rufescent than in others, but the difference is slight and there is as great a range of variation in the birds of one island as in another.

Individual variation in the series from the three islands is about the same and concerns the same features. In each series there are birds with the maxillary stripes absent, and others in which this marking appears to a slight degree, never conspicuously. In each, dorsal coloration varies between darker and lighter extremes to about the same degree, with the blackest backed individual from James; this feature is influenced by abrasion of the plumage. From Jervis and from Bindloe there are birds that show clusters of small spots upon the breast. The smaller series from James does not include any such individuals. There are no juvenal-plumaged specimens from any of the three islands. The most worn and faded specimens are December-taken birds.

66. *Nesomimus parvulus personatus* Ridgway

Nesomimus personatus Ridgway, 1890, p. 104 (orig. descr.; Abingdon Id.); 1897, p. 488; 1907, p. 252.

Nesomimus melanotis personatus Rothschild & Hartert, 1899, p. 144; 1902, p. 382.

Nesomimus personatus personatus Snodgrass & Heller, 1904, p. 363.

Nesomimus melanotis Gifford, 1919, p. 212, part.

NESOMIMUS PERSONATUS Ridgway

Type.—United States National Museum, no. 116098; ♂ ad.;

Abingdon Island; April 16 (1888); U. S. Fish Commission, Voyage of the Albatross, 1887-88.

HABITAT.—Abingdon Island.

Thirty specimens, collected on Abingdon Island, September 18-22, 1906 (nos. 3917-3946). A slightly differentiated race, so nearly like *N. p. bindloei* that the only difference I can detect between them is a slight average difference in length of culmen. *Personatus* has a longer bill. As regards dorsal coloration and presence or absence of submalar streak, the features upon which Snodgrass & Heller (1904) based their grouping of certain forms into a "*Nesomimus personatus* series" and "*Nesomimus melanotis* series," these characters fall down so lamentably in large series that the first mentioned is of no value even for subspecific differentiation, and the second of but very little. They are both valueless in distinguishing between the subspecies *personatus* and *bindloei*.

67. *Nesomimus parvulus wenmani*, new subspecies

Nesomimus melanotis melanotis Rothschild & Hartert, 1899, p. 145, part (Wenman Island); 1902, p. 382, part.

Nesomimus melanotis Gifford, 1919, p. 212, part.

Nesomimus melanotis barringtoni Snodgrass & Heller, 1904, p. 368, part (Wenman Island).

Nesomimus barringtoni Ridgway, 1907, p. 256, part (Wenman Island).

Type. —Male adult, no. 4177, Mus. Calif. Acad. Sci.; Wenman Island, Galapagos Archipelago; September 21, 1906: collected by E. W. Gifford; orig. no. 3606.

CHARACTERS: A slightly differentiated form of *Nesomimus parvulus*, most nearly like *bindloei*, *personatus*, and *hulli*. Distinguished from *bindloei* and *personatus* by slightly paler dorsal coloration and wider wing bars; from *hulli* by the much less apparent submalar streaks.

HABITAT.—Wenman Island.

Nine specimens, six males and three females, collected on Wenman Island, September 24, 1906 (C. A. S. nos. 4177-4185).

The Wenman Island *Nesomimus* has been referred to "*melanotis*" (= *bindloei*) by Rothschild & Hartert (1899, p. 145), and to *barringtoni*, of Barrington Island, by Snodgrass & Heller (1904,

p. 368), with comments in each case upon the peculiarity of distribution that places the one form upon these widely separated islands, with other species interposed between. I can concede the close resemblance to the James Island form, but I do not understand the ascription of Wenman Island birds to the subspecies of the far distant Barrington Island. In the series at hand from the two islands, length of culmen alone suffices to distinguish

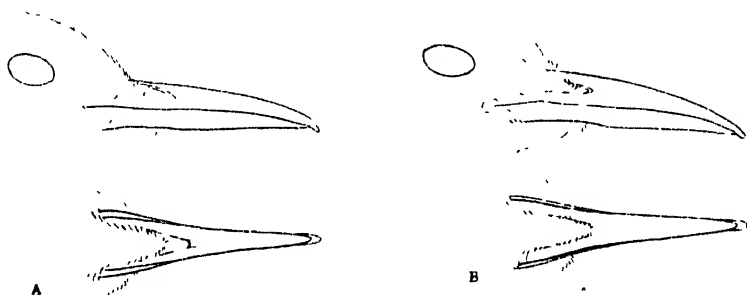


Fig. 17. a, *Nesomimus parvulus wenmani*, male (no. 4177, type), Wenman; *N. p. hulli* (no. 4187), Culpepper. Natural size.

them, and length of white spot on outer rectrices is another excellent differentiating character (see table of measurements).

Compared with birds from the nearby Culpepper Island (*hulli*), Wenman Island specimens are very closely similar. In *hulli* the submalar streaks are strongly in evidence, in *wenmani* they are usually absent, and when present at all are but faintly indicated.

68. *Nesomimus parvulus hulli* Rothschild

Nesomimus hulli Rothschild, 1898a, p. liii (orig. descr.; Culpepper Island).—Ridgway, 1907, p. 254.—Hartert, 1920, p. 478 (particulars of type specimen, in the Rothschild Museum).

Nesomimus melanotis hulli Rothschild & Hartert, 1899, p. 145.

Nesomimus personatus hulli Snodgrass & Heller, 1904, p. 365.

Nesomimus melanotis Gifford, 1919, p. 212, part (habits).

NESOMIMUS HULLI Rothschild

Type.—Rothschild Museum; ♂ ad.; Culpepper Island; July 27, 1897: R. H. Beck (Webster-Harris expedition); orig. no. 166.

HABITAT.—Culpepper Island.

There are thirteen specimens at hand, eight in the Academy collection, taken September 25, 1906 (nos. 4187-4194), and five

in the Stanford University collection, taken December 10, 1898. In all these birds the black submalar streak is fairly well defined; in several it is continued as a series of spots spreading over the breast on each side. The presence of the submalar streak, and the slightly paler dorsal color, are the best characters of *hulli*, as compared with *wenmani*. Rothschild & Hartert's (1899, p. 145) ascription of wider white tips to the primaries and secondaries of *hulli* is to some extent borne out in our series, but it is a slight difference and one that is quickly obscured by wear of the feathers.

69. *Nesomimus parvulus bauri* Ridgway

Nesomimus bauri Ridgway, 1894, p. 357 (orig. descr.; Tower Island); 1897, p. 492; 1907, p. 255.—Beck, 1904, p. 5, fig. (habits).—Hartert, 1920, p. 478 (particulars of type specimen, in Rothschild Museum).

Nesomimus personatus bauri Snodgrass & Heller, 1904, p. 362.

Nesomimus melanotis Gifford, 1919, p. 210, part (habits).

NESOMIMUS BAURI Ridgway

Cotype.—Rothschild Museum; ad., sex?; Tower Island; Sept. 2, 1891; Dr. G. Baur; orig. no. 695.

Cotype.—Rothschild Museum; ♀ ad.; Tower Island; Sept. 2, 1891; Dr. G. Baur.

Cotype.—Rothschild Museum; ad.; sex?; Tower Island; no date; Dr. G. Baur; orig. no. 683.

All three made up "from spirits". No type specimen was designated by Ridgway, but no. 695 bears a Rothschild Museum and a U. S. National Museum red "type label".

HABITAT.—Tower Island.

Nineteen specimens collected September 14 and 15 (C. A. S. nos. 4195-4213); from the Stanford University Museum, 10 specimens, collected June 22, 23, 1899.

A well marked form distinguished by long culmen, pale coloration dorsally, and, in most cases, well defined dark maxillary stripes. Several birds show small flecks of dusky at the sides of the upper breast. In one or two the maxillary stripes are almost wanting.

70. *Dendroica petechia aureola* (Gould)

- Sylvicola aureola* Gould, 1841 (= Nov., 1839), p. 86, pl. 28 (orig. descr.; Galapagos Archipelago).
Dendræca aureola Sclater & Salvin, 1870, p. 323.—Salvin, 1876, p. 473; 1883, p. 420.—Sharpe, 1877, p. 66; 1885, p. 282.
Dendroica aureola Ridgway, 1890, p. 105; 1897, p. 493.—Rothschild & Hartert, 1899, p. 147; 1902, p. 384 (nest and eggs).—Snodgrass & Heller, 1902, p. 520 (Cocos Id.).
Dendroica petechia aureola Ridgway, 1902, p. 521.—Snodgrass & Heller, 1904, p. 356.—Chapman, 1917, p. 545 (crit.); 1926, p. 594.—Peters, 1927, p. 40 (monograph).
Dendræca petechia Sundevall, 1871, p. 124.—Gifford, 1919, p. 216 (life hist.).
 [*Dendræca petechia*] f. *gallapagensis* Sundevall, 1869, p. 608.
Dendræca petechia gallapagensis Gyldenstolpe, 1927, p. 30 (particulars of type specimen, in Royal Natural History Museum, Stockholm).

SYLVICOLA AUREOLA Gould

Type.—British Museum, no. 56.3.15.10; ♂ ad.; Galapagos; C. Darwin.

[A date that is upon the label, "Jan. 4, 1839," indicates when the specimen was presented to the Zoological Society. N.B.K.]

DENDRÆCA PETECHIA GALLAPACENSIS Sundevall

Type.—Royal Natural History Museum, Stockholm, no. 13905; ♂ ad.; Charles Island; May, 1852; "Eugenie" expedition.

HABITAT.—Cocos Island and the Galapagos Islands.

The Academy series contains 201 specimens (nos. 4335-4535), as listed in the accompanying table. While not all of the islands are represented, the species was observed throughout the archipelago (Gifford, 1919, p. 216). It is apparently resident in the Galapagos, though I can find no explicit statement to that effect in any published writing; specimens in our series were collected practically throughout the year.

According to Gifford (*loc. cit.*), eggs are laid from the end of January until the middle of April. We have birds in juvenal plumage taken on Chatham, February 23, on Charles, March 2, and on Albemarle, March 12. An adult male collected on March 13 is in the midst of the annual molt, others taken toward the end of May have nearly finished the change. The sequence of plumages acquired is not yet understood (see Ridgway, 1902, pp. 516, 522) and our series of skins is not accompanied with data explanatory of the changes undergone. This much seems apparent, that the normal adult male has a chestnut pileum and

is heavily marked below with chestnut streaks, that the adult female is rather bright yellow, unmarked, below, and that the juvenal plumage is almost pure white below, tinged with brownish above.

There is, however, a grayish plumage that may or may not be an immature stage of the female; Ridgway (*loc. cit.*) believes that it is individual variation. In our series it is represented by many females taken at the right season to be in immature plumage, but there are February-taken females that are molting from a plain whitish to a yellow plumage. The few gray birds that are marked as males may, perhaps, have been wrongly so indicated, taken, as they were, at a season when the sexual organs are undeveloped and not easily distinguished.

There are a number of males in our series, taken mostly in May, that are about as follows in general appearance: Above (including pileum) plain olive green; back of neck and sides of neck grayish; throat almost pure white; rest of underparts yellowish, paler along the median line and on the lower tail coverts, dark greenish yellow on flanks. Breast and sides lightly but distinctly marked with longitudinal chestnut streaks. This, I believe, may be the normal immature male plumage, following the juvenal. A young male beginning the post-juvenal molt is apparently assuming this plumage, acquiring on the breast feathers that are pale yellowish, faintly marked with chestnut.

Among adult males there is a great variation in the brilliancy of the yellow ground color, in the extent of the chestnut ventral markings, and in the chestnut pileum. There are September birds (males), otherwise plain yellowish, with patches of newly growing chestnut-marked yellow feathers appearing on the breast, and chestnut feathers on the pileum, a strong indication of a partial pre-nuptial molt.

Only one or two of the islands are adequately represented in our series, but the specimens in hand carry no suggestion of differentiation into recognizable forms in different parts of the archipelago, either by color characters or measurements. The most that can be said is that the small series of adult males from Albemarle shows appreciably heavier chestnut markings below than in birds from any other island. Cocos Island specimens are like the mode from the Galapagos. While birds of this species are not regularly migratory, they seem in the Galapagos to pass freely from island to island. Gifford (1919, p. 219) says: "Of all the

Galapagos land birds, this warbler is met with most frequently away from the land," and he cites many instances. Such action would, of course, militate against the formation of distinguishable forms upon different islands.

I have not had available any representation of other forms of *Dendroica petechia* for comparison, so am accepting the conclusions of Chapman (1917, p. 545; 1926, p. 594) and Peters (1927, p. 40), both of whom regard *aureola* as confined to Cocos Island and the Galapagos Archipelago, and distinct from any mainland form.

SPECIMENS OF *Dendroica petechia aureola* IN THE COLLECTION
OF THE CALIFORNIA ACADEMY OF SCIENCES

Island	Adult male	Adult female	Immature	Juvenal
Cocos	4	2	4	
Culpepper			3	
Bindloe			1.	
James		2		
Jervis		1	1	
Albemarle	5	5	10	1
Duncan		1		
Indefatigable	13	2	4	
S. Seymour	1	1	1	
Chatham	40	25	5	1
Hood		2	5	
Gardner-near-Hood	2		1	
Charles	8	13	34	1
Champion			1	
Enderby			1	

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM) OF
Dendroica petechia aureola

Number of specimens	Island	MALES				
		Wing	Tail	Culmen	Tarsus	Middle toe with claw
4	Cocos	64.0 (62.2-65.2)	50.9 (49.2-52.2)	11.6 (11.2-12.0)	21.2 (20.5-22.0)	14.7 (14.2-15.0)
5	Albemarle	65.1 (63.8-66.2)	50.3 (49.0-51.5)	11.7 (11.0-12.5)	21.6 (21.0-22.0)	15.1 (15.0-15.2)
10	Indefatigable	65.5 (63.0-67.5)	50.8 (48.5-52.0)	11.8 (11.2-12.2)	21.3 (21.0-21.8)	15.1 (14.5-15.2)
10	Chatham	64.9 (62.0-66.2)	50.8 (48.5-52.5)	11.7 (11.5-12.2)	21.2 (21.0-21.5)	14.9 (14.5-15.2)
2	Gardner-near-Hood	65.5-65.5	50.2-52.0	10.8-11.5	21.5-21.5	14.0-15.0
8	Charles	65.9 (64.5-66.5)	51.7 (50.0-53.8)	11.9 (11.5-12.2)	21.2 (20.8-22.0)	14.8 (14.5-15.2)
FEMALES						
2	Cocos	61.2-62.5	48.2-49.5	11.2-11.5	20.0-20.5	13.0-14.0
4	Albemarle	61.9 (58.2-65.0)	49.5 (46.2-51.5)	11.3 (11.0-12.0)	21.1 (21.0-21.2)	14.3 (14.0-15.0)
2	Indefatigable	63.5-65.0	52.0-52.0	11.0-11.5	21.0-21.5	15.0-15.0
10	Chatham	60.9 (58.0-63.8)	47.9 (45.2-50.0)	11.5 (11.0-12.0)	20.8 (20.5-21.2)	14.0 (13.5-14.5)
2	Hood	62.2-64.2	50.5-51.0	10.5-11.5	20.5-20.5	14.0-14.0
10	Charles	62.7 (61.5-63.5)	50.2 (48.5-51.0)	11.4 (10.5-12.0)	20.8 (20.2-21.2)	14.4 (13.5-15.0)

71. *Dolichonyx oryzivorus* (Linnæus)

Dolichonyx oryzivorus Gould, 1841, p. 106 (James Id.).—Salvin, 1876, p. 491.—Sclater, 1886, p. 331.—Ridgway, 1897, p. 567; 1902, p. 370.—Rothschild & Hartert, 1899, p. 171.—Snodgrass & Heller, 1904, p. 272.—Gifford, 1919, p. 257.

One bird, now in the British Museum, was collected by Darwin on James Island in October, 1835 (Gould, *loc. cit.*). "The Harris expedition obtained a young male on Charles and a female on Chatham Island, the former in November, the latter in October and several others were seen" (Rothschild & Hartert, *loc. cit.*).

The Academy expedition reported two birds that alighted on the ship at points between the Galapagos and the coast of Mexico, on September 28 and October 3, 1906, respectively (Gifford, *loc. cit.*). The first of these birds was collected, a female in fresh fall plumage (no. 8711).

The above occurrences are numerous enough to justify us in regarding the species as of something more than casual occurrence in the Galapagos. Apparently in the far reaching southward migration of the Bob-o-link there are every year individuals along the western margin of the movement that alight upon the islands. Presumably such migrants are birds that strike out due southward from the coast of Mexico.

Family GEOSPIZIDÆ

A group of birds confined to the Galapagos Islands and Cocos Island, and, on the basis of external features, characterized as follows: "An assemblage of Passerine forms of small and medium size (wing 48.0 to 95.0 mm.). Wing rather short and rounded; tail rounded, much shorter than wing. Tarsus and toes long, outstretched feet extending beyond tip of tail. Rictal bristles obsolete. Bill extremely variable in relative length, depth, and width. Feathers on lower back and rump long, dense, and fluffy. Coloration unlike in adult male and female (except in *Cactospiza* and some forms of *Certhidea*), but with great variability on different islands in the number of males of any given form that ever attain 'adult' plumage. Color of bill varies seasonally and with age, being black or dusky in adults of both sexes during the breeding season, yellowish or otherwise light colored in adults at other seasons and in the young" (Swarth 1929, p. 31).

Included in this family group I recognize the genera *Geospiza*, *Platypiza*, *Camarhynchus*, *Cactospiza*, *Pinaroloxias*, and *Certhidea*. My reasons for the recognition of the family Geospizidæ (of which the first five genera listed were formerly allotted to the Fringillidæ, the last, *Certhidea*, to the Cœrebidæ or to the Mniotiltidæ) are given in full in the paper just cited. Briefly, my conclusions were based upon Snodgrass's (1903) study of the anatomy of the birds, as regards internal features, and, as to externals, upon certain observed common features of proportion, plumage structure, peculiarities in variations in color of bill, and peculiarities in manner of acquisition of certain plumages. It may be added that insofar as breeding habits are known (and nests were found of all the genera by the Academy expedition), the nests all follow the same peculiar type of construction, being dome-shaped, covered structures, with the entrance at the side. Eggs at hand of *Geospiza*, *Platypiza*, *Camarhynchus*, and *Certhidea*, are all very much alike in their general characteristics.

My course in establishing this family has called forth criticism (not published) from men whose opinions I value, the position they take being that the Geospizids are obviously of the Fringillidæ. It may be so, but after careful consideration of the assertion (no proof is offered) I am not convinced. In all previous treatments of these birds the fringilline aspect of the bill of some of the species has been given undue importance, just as the enormous

bill of *Geospiza magnirostris* has been uncritically assumed to imply "Coccothraustine" affinities. It seems to me clear beyond a doubt that the extremes represented by *Geospiza magnirostris* and the species of *Certhidea* are more closely related to each other than either is to any mainland form, in other words that those extremes have been produced since colonization of the islands. Even if their immediate common ancestor were of fringilline affinities, it seems to me that the group is now deserving of the rank I have ascribed to it. The "very large assemblage of species arbitrarily considered as forming a family Fringillidæ" (Ridgway, 1901, p. 24) is already so difficult of satisfactory definition that the addition to the group of still other forms previously ascribed to the Mniotiltidæ would seem to debar any definition at all. Even allowing the debatable nature of some aspects of the classification of the Geospizids, I believe that there is justification in the establishment of the family Geospizidæ. Such recognition is certainly in accord with the facts and principles stated by Ridgway (1901) in his discussion of avian classification (especially as regards the definition of families) in the introductory chapters of his monograph on American Fringillidæ. Any argument advanced against recognition of the family Geospizidæ applies with equal force to the generally accepted family of tanagers, Thraupidæ, and also, from the anatomical studies of Sushkin (1929, pp. 375, 379), to the Icteridæ and to the Hawaiian Drepanididæ.*

*When this publication was nearly through the press I found the following citation: "*Tiaris* is most intimately related to the famous Galapagos finches, *Geospiza*, presenting one instance more of the affinities between the fauna of the Galapagos and Antilles. [It is to be noted that *Certhidea* is a modified form of the same, Geospizine assemblage, and not Mniotiltine.]" (Sushkin, Auk, XLII, 1925, 261.) See pages 27-28, *antea*.

	Calipsoyer	Wenman	Abingdon	Endsloe	Tower	James	Jervis	Daphne	Seymour	Indefatigable	Duncan	Albemarle	Narborough	Battle	Barrington	Chatham	Hood	Caribbean-Hood	Charles	Caribbean-Charles
<i>Geospiza magnirostris</i>	●	●	●	●	●	●	●		●	●	●	●			●					
<i>Geospiza fortis</i>		●	●	●		●	●	●	●	●	●	●	●		●	●	●	●	●	●
<i>Geospiza ful. fuliginosa</i>						●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
<i>Geospiza ful. minor</i>		●	●	●											●	●	●	●	●	●
<i>Geospiza acutirostris</i>					●															
<i>Geospiza difficilis</i>			●																	
<i>Geospiza debilirostris</i>						●				●										
<i>Geospiza s. septentrionalis</i>		●																		
<i>Geospiza s. nigrescens</i>	●																			
<i>Geospiza s. intermedia</i>									●	●	●	●			●	●			●	●
<i>Geospiza s. scandens</i>						●	●													
<i>Geospiza s. rothschildi</i>				●																
<i>Geospiza s. abingdoni</i>			●																	
<i>Geospiza c. propinqua</i>	?				●															
<i>Geospiza c. contrirostris</i>																	●	●		
<i>Platyspiza crassirostris</i>			●	●		●	●			●	●	●	●			●				●
<i>Camarhynchus habeli</i>			●	●																
<i>Camarhynchus psittacula</i>						●	●			●	●	●			●					●
<i>Camarhynchus affinis</i>						●				●		●	●							
<i>Camarhynchus pauper</i>																				●
<i>Camarhynchus p. parvulus</i>		●	●			●	●			●	●	●	●		●				●	●
<i>Camarhynchus p. salvini</i>																●				
<i>Camarhynchus conjunctus</i>																				●
<i>Camarhynchus aureus</i>																●				
<i>Cactospiza giffordi</i>										●										
<i>Cactospiza p. pallida</i>						●	●	●	●	●	●									●
<i>Cactospiza p. producta</i>												●								
<i>Cactospiza p. striaticeps</i>																●				
<i>Cactospiza heliobates</i>												●	●							
<i>Certhidea ridgwayi</i>																				●
<i>Certhidea cinerascens</i>																		●	●	
<i>Certhidea bifasciata</i>															●					
<i>Certhidea luteola</i>																●				
<i>Certhidea olivacea</i>						●	●			●	●	●	●							
<i>Certhidea mentalis</i>					●															
<i>Certhidea fusca</i>			●	●																
<i>Certhidea becki</i>	●	●																		

Fig. 18. Chart showing known distribution of the species of the *Geospizidae* over the more important islands of the Galapagos Archipelago. Genera are separated by double lines. Closely related forms (species or subspecies) are segregated together between heavy lines. It will be noted that of the forms placed together between heavy lines, the only instances where two such forms occur upon any one island is in the case of *Camarhynchus psittacula* and *C. affinis* upon James and Seymour, due to the occurrence of stray individuals of *affinis* into the normal habitat of *psittacula*, and of *C. psittacula* and *C. pauper* upon Charles. With these exceptions the forms here listed together between heavy lines are complementary to one another in their distribution over the islands of the Archipelago, indicative of close, frequently subspecific relationship. In other words, the species and subspecies so segregated (ranging from one to eight in number) may be regarded as comprising fourteen units, some more or less sharply divided into species or subspecies, others not appreciably different upon different islands, forming the *Geospizid* population of the Galapagos.

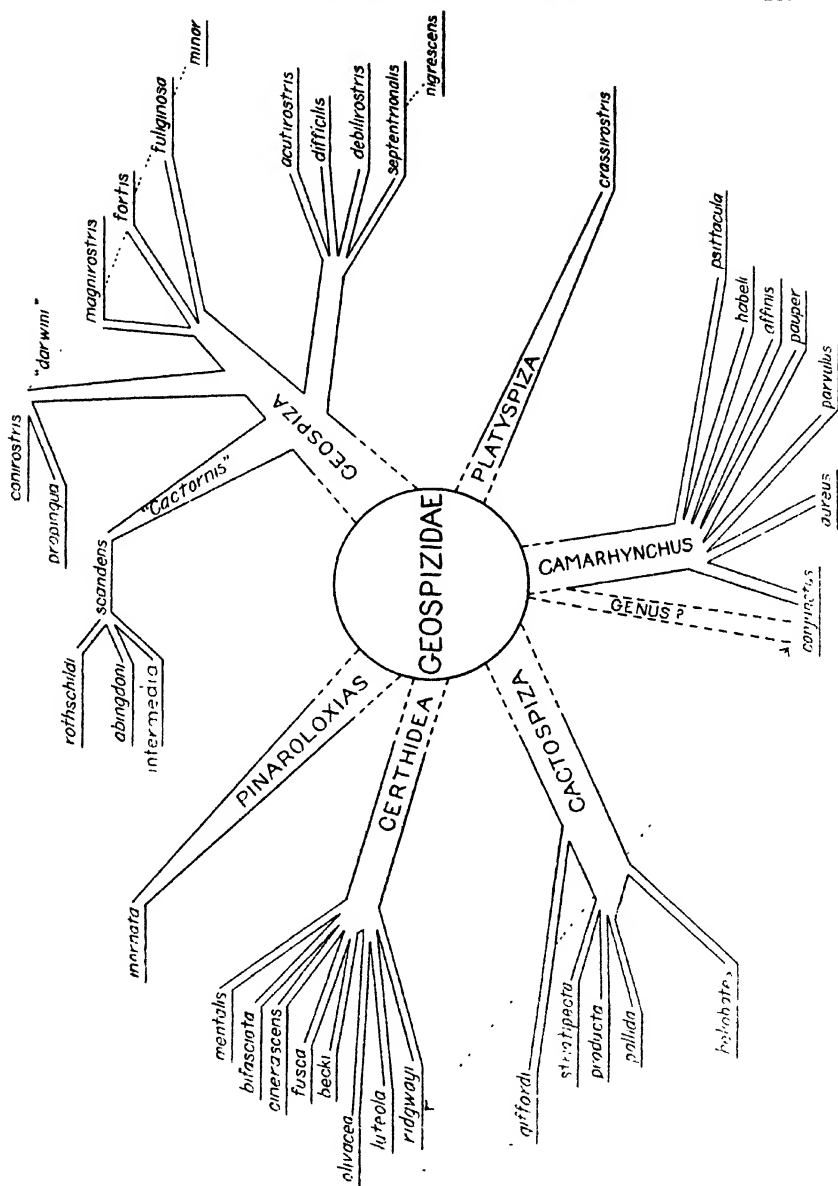


Fig. 19. Relationships of the species of the Geospizidae. The family (Geospizidae) is regarded as a tree-trunk, seen in cross-section from above. The main branches (genera) are here placed in relation to one another as they now seem, judging from resemblances; points of origin upon the trunk (relative distance from the beginning, at the ground) can not be determined from our point of view. The visible outward twigs (species and species), placed as nearly as may be in order of resemblances, form practically a circle. Dotted lines indicate intergradation or obvious resemblances. It is a debatable question whether *conjugatus* belongs upon the branch *Camarhynchus*, or represents a distinct genus.

GENERA OF GEOSPIZIDÆ

GEOSPIZA	PLATYSPIZA	CAMARHYNCHUS	CACTOSPIZA	PINAROLOXIAS	CERTHIDÆ
Sexes unlike	Sexes unlike	Sexes usually unlike	Sexes alike	Sexes unlike	Sexes usually alike
Size variable, from largest in family (wing 95 mm.) down to nearly the smallest (wing 55 mm.)	Size large (wing 80-85 mm.)	Size small and medium (wing 55-75 mm.)	Size medium (64-77 mm.)	Size medium (wing 68 mm.)	Size small (wing 48-56 mm.)
Color: Perfect male plumage black, except under tail coverts. Female and immature in some species dusky. In some streaked	Color: Perfect male plumage usually with black; head and upper breast black; sometimes all female and immature in some species entirely black. Female and young streaked	Color: In most species, perfect male plumage with head and breast black; female and young streaked above and below, or nearly immaculate below. In two species no black marking. One species with chestnut on throat	Color: Plain gray, olivaceous or dusky. No conspicuous markings. One species with faint chestnut markings on throat	Color: Perfect male plumage black except under tail coverts. Female and immature streaked	Color: Brownish olivaceous or pale gray. In several species male has chestnut on throat and breast
Bill variable, from very large to small; "finch-like" or "starling-like"; culmen convex; gonys straight or slightly convex	Bill short, deep, and broad; culmen strongly convex; gonys straight	Bill variable, but usually short and stout, laterally compressed, culmen convex, usually strongly so, gonys slightly to strongly convex	Bill relatively slender, "tanagers-like". Culmen convex; gonys slightly convex	Bill slender, sharp-pointed and decidedly decurved; culmen curved; gonys straight	Bill rather small, slender, and sharp-pointed; culmen slightly decurved; gonys straight or slightly convex
Tarsus relatively short; ratio of "middle toe with claw" to tarsus about 9 : 10	Tarsus relatively long; ratio of "middle toe with claw" to tarsus about 8 : 10	Tarsus relatively long; ratio of "middle toe with claw" to tarsus about 8 : 10	Tarsus intermediate in length; ratio of "middle toe with claw" to tarsus about 4.5 : 10	Tarsus relatively long; ratio of "middle toe with claw" to tarsus about 8 : 10	Tarsus relatively long; ratio of "middle toe with claw" to tarsus about 7 : 10

Genus GEOSPIZA Gould

Geospiza Gould, Proc. Zool. Soc. London, part V, 1837a, p. 5. (Type, *Geospiza magnirostris* Gould.)

Cactornis Gould, Proc. Zool. Soc. London, part V, 1837a, p. 6. (Type, *Cactornis scandens* Gould.)

Geospizidæ of variable size, from the largest down to nearly the smallest in the family; coloration, in the high-plumaged male uniformly black, except that the under tail coverts are varied with white or buff, female and immature in some species dusky, in some streaked; bill variable, from very large to small, finch-like or starling-like in shape, culmen convex, gonys straight or slightly convex; tarsus relatively short, ratio of "middle toe with claw" to tarsus about 9 : 10. (See Ridgway, 1901, p. 489, for structural details.)



Fig. 20. *Geospiza magnirostris*, male; coll. British Museum, no. 37.2.21.402; natural size. One of Darwin's specimens, from which the species was named. Drawing by H. Grönvold.

72. *Geospiza magnirostris* Gould

Geospiza magnirostris Gould, 1837a, p. 5 (Galapagos Ids.; orig. descr.); 1841, p. 100, pl. 36.—Salvin, 1876, p. 479.—Sharpe, 1888, p. 7.—Ridgway, 1897, p. 512; 1901, p. 495.—Rothschild & Hartert, 1899, p. 154; 1902, p. 388.—Snodgrass & Heller, 1904, p. 332.—Rothschild, 1907, p. 11, pl. 3 (fig. 1).—Gifford, 1919, p. 224.

Geospiza strenua Gould, 1837a, p. 5 (Galapagos Ids.; orig. descr.); 1841, p. 100, pl. 37 ("James and Chatham Islands").—Sclater & Salvin, 1870, p. 323.—Sundevall, 1871, p. 124.—Salvin, 1876, p. 479, figs.—Sharpe, 1888, p. 8.—Ridgway, 1890, p. 105; 1897, p. 514; 1901, p. 496.—Rothschild & Hartert, 1899, p. 155; 1902, p. 388.—Snodgrass & Heller, 1904, p. 330.—Rothschild, 1907, pl. 3 (fig. 2).

Geospiza pachyrhyncha Ridgway, 1896, p. 293 (Tower Id.; orig. descr.); 1897, p. 516; 1901, p. 498.—Rothschild & Hartert, 1902, p. 388 (crit.).—Beck, 1904, p. 5 (habits).

Geospiza darwini Rothschild & Hartert, 1899, p. 158 (Culpepper Island; orig. descr.).—Ridgway, 1901, p. 500.—Snodgrass & Heller, 1904, p. 330.—Hartert, 1919, p. 152 (particulars of type specimen, in Rothschild Museum).

Geospiza conirostris darwini Rothschild & Hartert, 1902, p. 389.

Geospiza conirostris Gifford, 1919, p. 225, part.

GEOSPIZA MAGNIROSTRIS Gould

Cotype.—British Museum, no. 55.12.19.80; (♂ ad.; Galapagos Islands); Charles Darwin; received from Zoological Society of London.

Cotype.—British Museum, no. 55.12.19.113; (♀♀; Galapagos Islands); Charles Darwin; received from Zoological Society of London. The above two specimens are the ones entered by Sharpe (1888, p. 8) as "types of species." The male now bears a red "type label." The additional five skins listed below seem to have valid claims to be regarded as cotypes.

Cotype.—British Museum, no. 37.2.21.402; (♂ ad.; Galapagos Islands); received from Burnett and Fitzroy.¹

Cotype.—British Museum, no. 37.2.21.403; (sex?; Galapagos Islands); received from Burnett and Fitzroy.²

Cotype.—British Museum, no. —; (sex?; Galapagos Islands); received from Burnett and Fitzroy.³

Cotype.—British Museum, no. 85.12.14.280. (♂ ad.; Galapagos Islands); Charles Darwin; Salvin-Godman coll. (ex T. C. Eyton coll.).

Cotype.—British Museum, no. 85.12.14.281; (♀; Galapagos Islands); Charles Darwin; Salvin-Godman coll. (ex T. C. Eyton coll.).

GEOSPIZA STRENUA Gould

Cotype.—British Museum, no. 55.12.19.18; (♂ ad.; Galapagos Islands): "October"; Charles Darwin: received from Zoological Society of London.

Cotype.—British Museum, no. 55.12.19.83; (♀♀; Galapagos Islands); received from Zoological Society of London.

Cotype.—British Museum, no. 55.12.19.114; (♀♀; Galapagos Islands): received from Zoological Society of London.

Cotype.—British Museum, no. 37.2.21.396; (♂ ad.; Galapagos Islands)⁴; Burnett and Fitzroy. The first three specimens listed

¹ Charles Island. N.B.K.

² Sim. Charles Island. N.B.K.

³ No. 87.2.21.398; ♀; Charles Island. N.B.K.

⁴ Chatham Island. N.B.K.

Data supplied by Mr. Kinnear from sources other than the labels upon the skins.

above were indicated by Sharpe (1888, p. 9) as "types of species"; no. 55.12.19.18 is now distinguished with a red "type label."

GEOSPIZA PACHYRHYNCHA Ridgway

Cotype.—Rothschild Museum. (Specimen A, ♀?) Tower Island; Dr. Baur; ex spirits.

Cotype.—Rothschild Museum. (Specimen B, ♀?) Tower Island; Dr. Baur, no. 668.

Ridgway indicated no type specimen, but said (1896, p. 293) "type in Dr. Baur's collection"; and again (1901, p. 498, footnote) "Now in the Tring Museum collection". The above listed specimens are the only ones now in the Rothschild Museum, and neither has been labelled as the type. Ridgway's measurements were

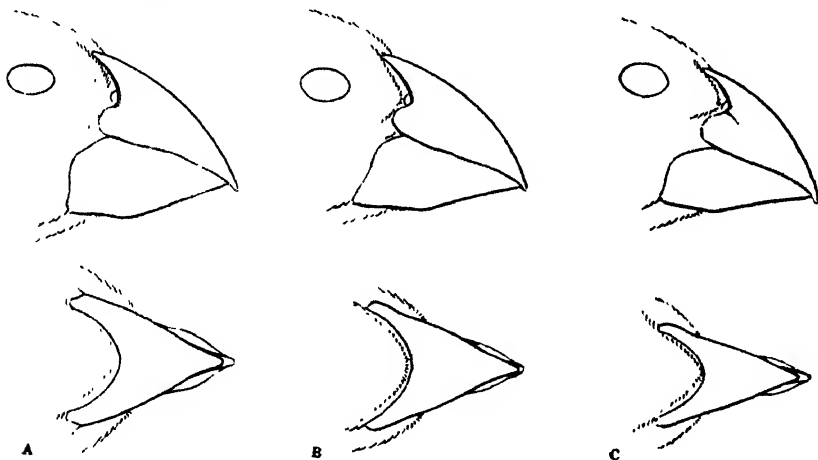


Fig. 21. *Geospiza magnirostris* (males): a (no. 5310), Tower; b (no. 5104), James; c (no. 5329), Jervis. Natural size.

from a drawing (see 1897, pl. LVII, fig. 9), made either from another specimen or as a composite of these two. Specimen A (so marked by myself on the label) matches the lateral drawing to a hair's breadth, but not the ventral view. Specimen B matches the ventral drawing perfectly, but not the lateral one. Rothschild & Hartert's figure (1899, pl. VI, fig. 8) is an accurate reproduction of the bill of specimen B.

GEOSPIZA DARWINI Rothschild & Hartert

Type.—Rothschild Museum: ♂ ad.: Culpepper Island: July 27. 1897: R. H. Beck (Webster-Harris expedition); orig. no. 157.

No type specimen was indicated in the original description, but the above, out of a series, has been distinguished with a red "type label."

DESCRIPTION.—The largest and the largest-billed of the *Geospizidæ* (see measurements, p. 151). *Adult male*.—Uniform black except that the under tail coverts are more or less broadly margined with white or pale buff. *Adult female*.—Dusky appearing, more or less mottled above and streaked below, under tail coverts and (to a varying extent) center of abdomen being immaculate dingy whitish. Feathers of upper parts generally black or dusky centered, edged with grayish or olive-green, these edgings so broad on rump and upper tail coverts as to almost entirely hide the central dusky marking. Ground color below paler on center of abdomen, darker (olivaceous) on sides and flanks. Feathers from chin over breast and sides with broad, central blackish streaks. Rectrices and remiges blackish or dusky, with narrow pale edgings. Greater, median and lesser coverts broadly edged with gray, olivaceous; or rusty brown. *Juvenal*.—Essentially similar to the adult female, but with the feather-edgings on upper surface and wing coverts rather broader and more sharply contrasted, producing a somewhat scale-like effect. Male birds, in a plumage presumably following the juvenal and worn for an undetermined period thereafter, are exactly like the adult female.

Variants.—The "perfect" adult male, as described above, is solid black except for the under tail coverts, but many individuals vary from this condition, displaying more or less of narrow edgings to the body feathers, above and below. From this state of near perfection there is further variation by extension of pale markings, to a streaked condition indistinguishable from the female. Solid black areas appear first about head, neck, and upper breast. Females from the same island vary from one extreme of heavy ventral streaking to the other of being nearly immaculate below. Streaked birds (male and female) from the northern islands are, on the average, distinctly darker and more heavily marked than those from the more southern ones.

HABITAT.—Most of the Galapagos Archipelago, including all of the northern and central islands. Specifically known to occur upon the following: Culpepper, Wenman, Abingdon, Bindloe, Tower, James, Jervis, Albemarle, Narborough, Duncan, Indefatigable, Seymour, Barrington.

There are at hand 151 specimens* in the Academy collection and 35 in the Stanford University collection, taken at the following times: Culpepper, September 25; Wenman, September 24; Abingdon, June 24, 25, and September 18-22; Bindloe, June 20,

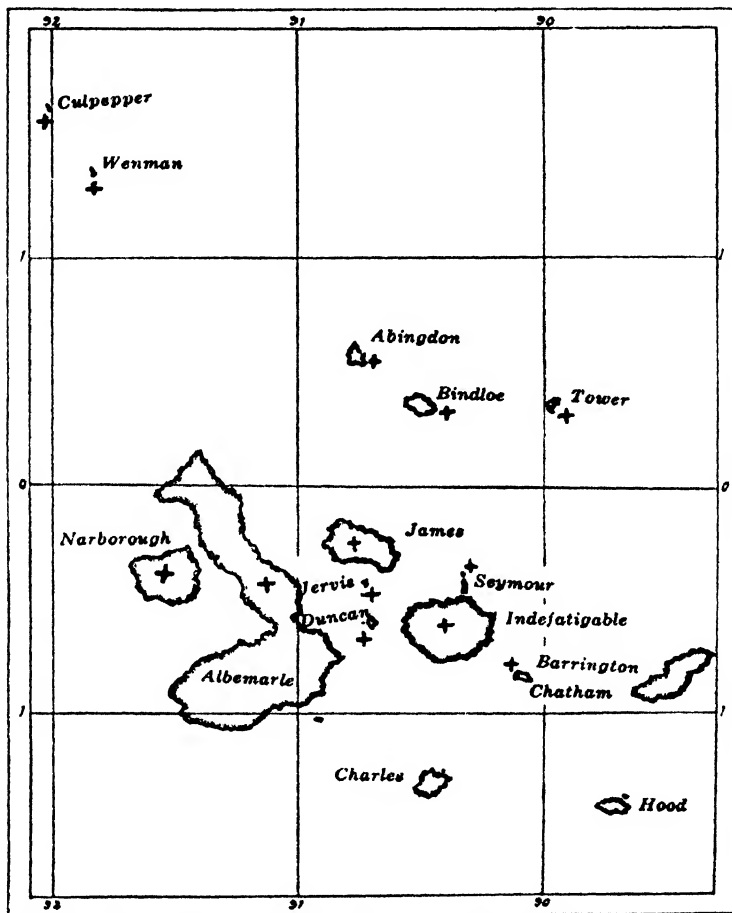


Fig. 22. Map showing distribution of *Geospiza magnirostris*. Symbols indicate islands where recorded.

21, and September 17; Tower, June 23, and September 14, 15; James, January, April, August and December; Jervis, December 18-21; Albemarle, March, April, August and November; Nar-

*Catalogued under the following numbers: 5099-5157, 5310-5335, 5337, 5481, 5488, 5550, 5551, 5953-6003, 6041, 6045, 6164, 6196, 6316, 6320, 6762, 6764-6766.

borough, January, March and April; Indefatigable, January, July and November; Seymour, November 21; Barrington, October 21.

Variation in bill color is as follows. Culpepper: Three black males, September 25, bill black. Wenman: Two black males, September 24, bill black; two females, bill light colored. Abingdon: One black male, September 19, and two females, September 22, bill black; remainder of September series (34) bill light colored. June 25, four black males, bill black; June 24, two streaked males and one female, bill light colored. Tower: June 23, three black males, bill black; one black male, one streaked male, two females, bill dusky. September 14, 15, one black male, bill black; two black males and two females, bill parti-colored; two streaked males and three females, bill light colored. Jervis: Of 20 black males, December taken, nearly all have bill black, in a few it is parti-colored; twelve females have bill black or dusky above, parti-color below. James: Four black males, April 21, 22, bill black. December and January, of 11 black males five have bill black, the others mostly dusky; streaked males and females have bill dusky above, or else are mostly light colored. In a streaked male taken on Albemarle April 14, and in a female taken on Indefatigable January 22, the bill is black.

Geospiza magnirostris was the first of the genus to be named, one of a series of species collected by Charles Darwin and collectively stated in Gould's paper, in general terms, to be from the Galapagos Islands. In the more elaborate treatment that followed (Gould, 1841, p. 100) this species is said to be from "Charles and Chatham Islands." Darwin's specimens eventually went to the British Museum, and in the "Catalogue of Birds" of that institution (Sharpe, 1888, p. 7) a pair of these birds, designated as types, are entered as from Chatham Island. The series of *magnirostris* in the British Museum comprises seven specimens, all from the "Beagle" expedition. The two "types" and three others from Burnett and Fitzroy had all been mounted for exhibition; two others (study skins), collected by Darwin, passed into the T. C. Eyton collection, then to Salvin and Godman, and then to the British Museum. That these birds came from either Charles or Chatham Island is unlikely.* No large-billed finch

*Mr. Kinnear has confidence in the accuracy of Fitzroy's ascription of specimens of *magnirostris* to Charles Island, of *strenua* to Chatham. But in this Darwin-Fitzroy collection there are no original labels that have survived to the present time; and there have been so many chances for dissociation of specimens and data that my every instinct impels me to rely upon the evidence supplied by the specific or subspecific characters of the specimens rather than on what has been written about them.

has been found upon those islands, and the assumption that *magnirostris* was native upon Charles, where it has been exterminated since Darwin's visit, seems to me to be unwarranted. Darwin's own statement regarding the confusion of localities has been cited in support of the Charles Island claims, but I can not so regard it. He says first: "Unfortunately most of the specimens of the finch tribe were mingled together; but I have strong reasons to suspect that some of the species of the subgroup *Geospiza* are confined to separate islands." Then: "Two species of the sub-group *Cactornis*, and two of *Camarhynchus*, were procured in the archipelago; and of the numerous specimens of these two sub-groups shot by four collectors at James Island all were found to belong to one species of each; whereas the numerous specimens shot either on Chatham or Charles Island (for the two sets were mingled together) all belonged to the two other species: hence we may feel almost sure that these islands possess their representative species of these two sub-groups" (Journal of Researches). It seems to me that the wording of this latter statement distinctly excludes *Geospiza*, and that it cannot be taken to have any bearing on the question as to whether Darwin collected a large billed *Geospiza* on Charles Island.

Darwin's itinerary on the "Beagle" began at Chatham Island, then southwest to Charles, northwest between Albemarle and Narborough, and around the north end of Albemarle to James. The present status of the large billed *Geospiza* upon these islands is as follows: non-existent upon Chatham and Charles; existent upon Albemarle and Narborough, but with bill size at the minimum; existent, and abundant, upon James, and with bill size close to the maximum.

A fact that our series brings out is that the largest billed birds are from the northern islands and that there is a decided reduction in bill size southward. The difference in this regard is striking, as between specimens from Culpepper, Wenman, Abingdon, Bindloe, Tower and James, on the one hand, and those from Jervis, Albemarle, Narborough, Indefatigable and Barrington, on the other. With this general trend of variation elsewhere in the archipelago it would be surprising if there were an extremely large-billed variant abruptly appearing on Charles, another southern island.

Gifford (1919, p. 225), in the published field notes covering the Academy collection that I am here reporting upon, states

under *Geospiza magnirostris*: "On Charles the largest-billed birds of all were taken." This sentence and the whole paragraph it introduces were inserted here by mistake, belonging properly under *Geospiza fortis*, as became apparent upon consulting his manuscript field note-book. The Academy expedition collected no large-billed *Geospiza* upon Charles Island.

I do not believe that *magnirostris* and *strenua* can be recognized as separate forms, and I do not believe that Darwin's specimens

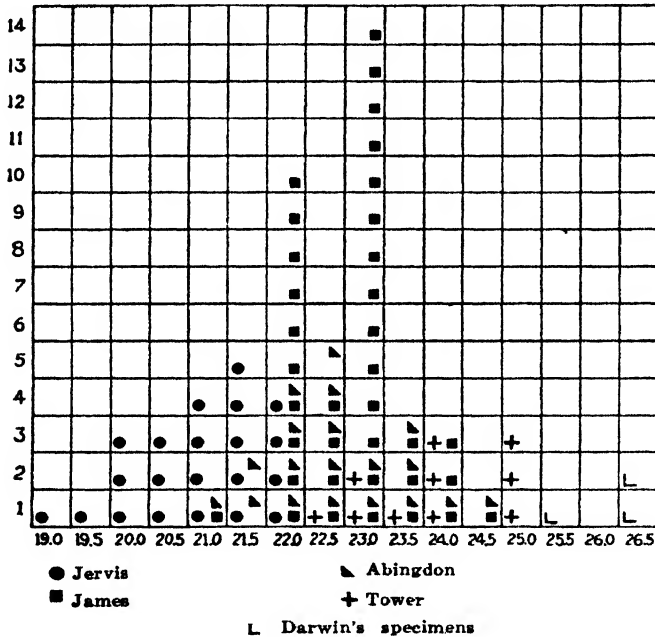


Fig. 23. Length of culmen in male specimens of *Geospiza magnirostris*: Jervis, 21; James, 36; Abingdon, 19; Tower, 10; also 3 specimens collected by Darwin, island unknown. Each symbol represents a specimen. Numerals at left of diagram indicate number of specimens; numerals at bottom, length of culmen in millimeters.

of *magnirostris* came from Charles Island. In all probability they were collected upon James Island, where Darwin did by far the greater part of his field work, and where at the present time size is near the maximum in this species. Admittedly the type series are a trifle larger than any birds since collected, but, even so, the difference is slight and it is not inconceivable that there has actually been some change in characters in the *magnirostris* population

since Darwin's time, that he collected his very large-billed birds upon James Island and that no such large-billed birds are to be found there today. I find this easier to believe than that this form was formerly existent upon Charles Island and has recently been exterminated there. The *Geospizidæ* throughout the Galapagos give the impression of being in a state of flux.

Geospiza strenua was described by Gould (1837, p. 5) from the "Galapagos Islands," restricted later (1841, p. 100) to "James and Chatham islands." Sharpe (1888, p. 8) lists the specimens collected by Darwin that formed the basis of Gould's description (entered as "types") as collected on Chatham Island, but inasmuch as no such heavy-billed *Geospiza* has since been found upon that island the conclusion was reached by Rothschild & Hartert (1899, p. 155) that a mistake was made and that the type must have come from James Island. These birds, however, particularly the male, have smaller bills than the male from James Island, more like those from Albemarle.

Ridgway (1896, p. 293) described *Geospiza pachyrhyncha* from Tower Island, differing from *strenua* in its deeper and broader bill. This type of bill is certainly developed to its utmost in Tower Island specimens, but merely to attach a name to the bird of this island does not tell the whole story. Bill structure in the Tower Island series is no more uniform than it is on other islands, and some smaller-billed adults from Tower have that feature no more largely developed than is the mode on Abingdon or on James. On the other hand, exceptional individuals on James and Abingdon closely approach the maximum of the Tower series. In other words, here is the overlapping of measurements that justified Rothschild & Hartert (1899, p. 156) and Snodgrass & Heller (1904, p. 330) in their refusal to recognize *pachyrhyncha*. The large size and large bill of the Tower Island form is part of a general trend to which I have previously alluded.

Geospiza darwini was described by Rothschild & Hartert (1899, p. 158) from Culpepper Island, and regarded by them subsequently (1902, p. 389) as a subspecies of *G. conirostris*. Examining their series I can appreciate the grounds upon which they acted (our own material is inadequate), but even so I can not bring myself to accept their conclusions. The female "*darwini*" is a streaked bird, as in *magnirostris*, and quite unlike the dusky female of *conirostris*, debarring treatment of this form as a subspecies of

conirostris in any event. The bill of "*darwini*" is on the average admittedly different from the mode of *magnirostris*, being compressed laterally and with more rounded culmen, intermediate in appearance between typical *magnirostris* and *conirostris*. Some specimens from Culpepper, though, are indistinguishable from *magnirostris*, and there are birds in our James Island series with the bill exactly as in "*darwini*." Thus, while there is a strong tendency toward the development of certain bill characters in the Culpepper bird, it hardly seems to justify a separate name.

MEASUREMENTS IN MILLIMETERS OF THE TYPE SERIES OF
Geospiza magnirostris IN THE BRITISH MUSEUM

No.	Sex	Wing	Tail	Culmen	Depth of bill at base	Width of mandible at base	Tarsus	Middle toe with claw
55.12.19.80	♂	89.0	51.5	25.5	23.5	16.8	26.5	22.5
37.2.21.402	♂	89.0	54.0	26.5	24.2	17.8	25.2	24.5
85.12.14.280	♂	90.0	54.2	26.8	24.0	17.8	25.0	24.5
55.12.19.113	♀ ?	84.5	51.0	24.5	23.2	17.2	25.5	21.0
37.2.21.403	♀ ?	87.0	51.0	24.8	.	17.0	25.0	23.0
	♀ ?	84.5	50.5	24.5	22.8	16.8	24.2	23.0
85.12.14.281	♀ ?	85.5	53.0	26.0	23.0	16.2	25.0	23.2

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM) OF
Geospiza magnirostris

MALES

Number of specimens	Island	Wing	Tail	Culmen	Gonys	Depth of bill at base	Width of mandible at base	Tarsus	Middle toe with claw
10 ¹	Culpepper	80.7 (78.0-84.0)	49.7 (46.0-53.2)	21.3 (19.5-22.8)	12.1 (12.0-12.2)	16.8 (14.2-19.5)	12.7 (11.0-14.0)	25.1 (23.5-26.5)	22.7 (19.5-24.0)
3	Culpepper	83.6 (80.2-85.5)	52.7 (51.5-54.5)	22.2 (21.0-23.0)	12.5-13.0	18.2 (17.5-18.8)	13.9 (13.5-14.2)	25.8 (25.5-26.0)	22.5 (21.5-23.0)
2	Wenman	84.0-85.0	52.5-53.0	23.0-24.0		20.0-20.0	14.5-15.0	25.5-26.0	23.5-24.0
10	Abingdon	80.0 (77.0-83.0)	48.9 (45.0-52.2)	22.2 (21.0-23.5)	12.1 (11.0-12.6)	20.1 (19.0-22.0)	15.3 (14.5-16.5)	24.9 (23.5-26.0)	21.5 (20.0-22.5)
4	Indio	79.3 (78.0-81.0)	48.7 (47.5-51.0)	21.8 (21.0-22.2)	11.5 (11.0-12.0)	19.0 (18.2-20.8)	14.6 (14.0-15.5)	24.1 (23.0-26.0)	20.6 (19.5-21.5)
10	Tower	83.6 (77.5-87.5)	51.5 (48.0-53.0)	23.9 (22.5-25.0)	12.4 (12.0-13.2)	21.2 (19.0-23.0)	15.9 (15.0-17.0)	25.0 (24.0-26.0)	22.6 (21.5-23.0)
10	James	82.3 (78.5-85.5)	50.0 (47.0-53.5)	22.7 (21.0-24.0)	12.4 (11.2-13.5)	21.2 (20.0-22.0)	15.6 (14.5-16.2)	25.0 (24.0-26.0)	22.3 (20.0-23.5)
10	Jervis	80.7 (77.0-83.5)	50.5 (48.0-54.0)	20.9 (19.0-22.2)	11.6 (11.0-12.0)	18.2 (17.0-20.0)	13.6 (12.5-14.0)	23.5 (21.0-24.5)	22.3 (20.0-23.5)
4	Albemarle	76.1 (74.0-80.0)	46.7 (43.5-53.2)	20.7 (19.0-22.0)	11.1 (10.5-12.0)	17.0 (15.5-19.0)	13.0 (12.5-14.2)	23.7 (22.5-25.0)	21.3 (20.5-22.2)
1	Narborough	79.0	47.2	22.0	11.5	19.0	14.2	24.0	21.0
6	Indefatigable	79.5 (74.0-83.5)	49.6 (44.0-53.5)	21.7 (20.5-22.5)	11.7 (11.0-12.2)	19.9 (17.2-21.0)	16.3 (12.5-16.5)	24.3 (23.0-25.0)	21.5 (20.5-22.5)
1	Barrington	80.0	48.5	20.8	12.0	16.0	13.0	22.5	22.0

¹"*Geospiza darwini*"; specimens in Rothschild Museum.

FEMALES

Number of specimens	Island	Wing	Tail	Culmen	Gonys	Depth of bill at base	Width of mandible at base	Tarsus	Middle toe with claw
4 ¹	Culpepper	77.7 (77.2-78.0)	49.6 (48.2-51.2)	21.9 (21.0-24.0)		17.2 (15.0-18.0)	12.8 (12.0-13.2)	24.2 (23.5-24.8)	20.9 (18.5-22.2)
10	Abingdon	77.1 (74.0-79.0)	46.5 (43.0-49.0)	22.0 (20.8-23.2)	11.7 (11.2-12.2)	19.3 (18.8-20.5)	14.6 (13.5-16.0)	23.7 (23.0-24.5)	21.9 (20.5-23.2)
7	Tower	79.9 (77.2-83.0)	49.2 (45.5-52.8)	23.8 (23.2-25.0)	12.4 (12.0-13.5)	21.4 (20.2-23.5)	16.8 (15.0-16.8)	24.7 (23.5-25.8)	22.5 (21.5-23.2)
10	James	78.9 (76.5-82.0)	47.5 (43.2-49.5)	22.5 (21.2-24.0)	12.1 (11.5-12.8)	20.0 (19.0-21.0)	15.3 (14.2-16.0)	24.6 (23.0-27.0)	21.1 (20.0-22.0)
10	Jervis	78.9 (77.5-81.0)	47.7 (46.0-50.0)	20.8 (19.5-22.2)	11.5 (10.5-12.5)	18.1 (16.5-20.0)	13.4 (12.5-15.0)	23.7 (22.5-24.2)	21.5 (20.5-22.5)
3	Albemarle	75.6 (75.0-76.2)	45.1 (42.0-47.2)	16.8 (15.2-18.0)	10.0 (9.5-10.5)	15.5 (14.5-16.5)	12.1 (11.2-12.5)	22.5 (22.2-23.0)	20.4 (20.0-21.2)
6	Indefatigable (3) and Seymour (3)	76.0 (72.5-78.0)	47.3 (42.5-51.5)	21.2 (20.2-22.2)	11.6 (11.0-12.5)	18.5 (15.5-19.8)	14.1 (13.0-15.0)	23.5 (22.2-24.8)	20.7 (19.5-21.2)

¹"*Geospiza darwini*"; specimens in Rothschild Museum.

SPECIMENS OF *Geospiza magnirostris* IN THE ACADEMY COLLECTION
AND (FIGURES IN PARENTHESES) IN THE STANFORD
UNIVERSITY COLLECTION

Island	Male (black)	Male (streaked)	Female	Young	Sex undetermined
Culpepper	2	1			
Wenman	2		2		1
Abingdon	1 (4)	14 (2)	21 (1)		
Bindloe	1 (2)	(1)	(1)		
Tower	3 (4)	2 (1)	5 (2)		(2)
James	19 (4)	13 (1)	9 (2)	(5)	1
Jervis	20	1	10		2
Albemarle		4	3	1	
Narborough	(1)		(2)		
Seymour		1	3		
Indefatigable	3	2	3		
Barrington	1				

73. *Geospiza fortis* Gould

- Geospiza fortis* Gould, 1837a, p. 5 (Galapagos Ids.; orig. descr.); 1841, p. 101, pl. 38 ("Charles and Chatham islands").—Sharpe, 1888, p. 10.—Ridgway, 1901, p. 502.
- Geospiza fortis fortis* Rothschild & Hartert, 1899, p. 161.—Snodgrass & Heller, 1904, p. 319.
- Geospiza dubia* Gould, 1837a, p. 6 (Galapagos Ids.; orig. descr.); 1841, p. 103 ("Chatham Island").—Sharpe, 1888, p. 9 (type specimen believed to have been lost).—Ridgway, 1901, p. 501.
- Geospiza dubia dubia* Rothschild & Hartert, 1899, p. 160.
- Geospiza fortis dubia* Snodgrass & Heller, 1904, p. 328.
- Geospiza fratercula* Ridgway, 1894, p. 363 (Abingdon Id.; orig. descr.); 1901, p. 504.
- Geospiza fortis fratercula* Rothschild & Hartert, 1899, p. 161.—Snodgrass & Heller, 1904, p. 326.
- Geospiza albemarle* Ridgway, 1894, p. 362 (Albemarle Id.; orig. descr.); 1901, p. 502.
- Geospiza dubia albemarle* Rothschild & Hartert, 1899, p. 160.
- Geospiza fortis platyrhyncha* Heller & Snodgrass, 1901, p. 75 (Iguana Cove, Albemarle Id.; orig. descr.).—Snodgrass & Heller, 1904, p. 327.
- Geospiza platyrhyncha* Ridgway, 1901, p. 673.
- Geospiza dubia simillima* Rothschild & Hartert, 1899, p. 161 (Charles Id.; orig. descr.).
- Geospiza simillima* Ridgway, 1901, p. 502.
- Geospiza fortis simillima* Snodgrass & Heller, 1904, p. 329.
- Geospiza dentirostris* Gould, 1837a, p. 6 (Galapagos Ids.; orig. descr.).—Rothschild, 1907, p. 12.
- Geospiza nebulosa* Gould, 1837a, p. 5 (Galapagos Ids.; orig. descr.); 1841, p. 101 (Charles Id.).
- Geospiza bauri* Ridgway, 1894, p. 362 (James Id.; orig. descr.).
- Cactornis brevirostris* Ridgway, 1890, p. 108 (Charles Id.; orig. descr.).

GEOSPIZA FORTIS Gould

Cotype.—British Museum, no. 55.12.19.82; (♀?; Galapagos Islands); received from Zoological Society of London.

Geospiza fortis was described and figured as having the male jet black, but although apparently no black male reached the British Museum, there must have been such, forming at least one other cotype.

GEOSPIZA NEBULOSA Gould

Type.—British Museum, no. 37.2.21.400; (♀); Charles Island: presented by Burnett and Fitzroy.*

GEOSPIZA DENTIROSTRIS Gould

Type.—British Museum, no. 55.12.19.176; (Galapagos Islands); Charles Darwin; received from Zoological Society of London.

"Mr. Gould considers the specimen a female, from the appearance of its plumage; but from dissection, I thought it was a male" (Darwin, 1841, p. 102).

GEOSPIZA FRATERCULA Ridgway

Type.—United States National Museum, no. 116110; (♂ ad.) Abingdon Island: April 16 (1888); C. H. Townsend: U. S. Fish Commission, Voyage of the Albatross, 1887-88.

GEOSPIZA ALBEMARLEI Ridgway

Type.—United States National Museum, no. 115977; ♂, streaked; Tagus Cove, Albemarle Island: April 10 (1888); C. H. Townsend; U. S. Fish Commission, Voyage of the Albatross, 1887-88.

GEOSPIZA DUBIA SIMILLIMA Rothschild & Hartert

Type.—Rothschild Museum: ♂ ad.: Charles Island: November 4, 1897: C. D. Hull (Webster-Harris expedition): orig. no. 2267.

GEOSPIZA FORTIS PLATYRHYNCHA Heller & Snodgrass

Type.—Leland Stanford Junior University, no. 5150: ♂ ad.: Iguana Cove, Albemarle Island: June 7, 1899: R. E. Snodgrass and E. Heller (Hopkins-Stanford Galapagos expedition); orig. no. 147.

GEOSPIZA BAURI Ridgway

Type.—Rothschild Museum: ♂ ad.: James Island: August 17, 1891: Dr. G. Baur: orig. no. 562.

*Sharpe (1888, p. 11) wrongly lists the type of this species as collected by Darwin and as received from the Zoological Society; actually it was collected by Captain Fitzroy N.B.K.

CACTORNIS BREVIROSTRIS Ridgway

Type.—United States National Museum, no. 115920; ♂ (adult but not entirely black); Charles Island; April 8, 1888; U. S. S. Albatross.

DESCRIPTION.—Differs from *Geospiza magnirostris* in smaller size and disproportionately smaller bill, from *G. fuliginosa* in larger size and disproportionately larger bill (see measurements, p. 165). In coloration and plumage stages I can see no differences between these species (see description of *G. magnirostris*, p. 144). Variation in shape of bill is such in each form as to preclude definition of specific differences of that nature.

HABITAT.—The greater part of the Galapagos Archipelago, including all of the central islands; perhaps only of casual occurrence on Wenman and Hood. The only parts of the group from which it has not been reported are the outlying islands of Culpepper, at the extreme north, and Tower, at the north-east.

There are at hand 812 skins in the Academy collection* and 125 in the Stanford University collection, representing every island upon which the species has been found (see table, p. 164). They were collected on the several islands upon seasons as follows: Wenman, September; Abingdon, June and September; Bindloe, June and September; James, January, April, August and December; Jervis, December; Indefatigable, January, July, October and November; Seymour, April, July and November; Daphne, July and November; Duncan, August and December; Albemarle, January, February, March, April, May, June, August, November and December; Narborough, January and April; Barrington, October; Charles, February, March, May, June and October; Gardner-near-Charles, October; Champion, October; Chatham, January, February, May, July, September and October; Hood, June and September; Gardner-near-Hood, February and September.

Variation in bill color is roughly as follows. Abingdon: in a series collected September 21, the bill is black in all but two, in which it is partly dusky. In a series collected in June there are three black males and one streaked male with black bill, and four streaked birds (perhaps immature) with light colored bill. Bindloe:

*The Academy series of *Geospiza fortis* is catalogued under the following numbers: 5096, 5158-5309, 5386, 5388-5423, 5433-5480, 5482-5487, 5489-5549, 5552-5606, 5762, 6004-6028, 6030-6040, 6042-6044, 6046-6163, 6165-6195, 6197-6315, 6317-6319, 6321-6367, 6475, 6767-6769, 6771-6775, 6777-6814, 6905.

in a series collected September 17, 18, the bill is light colored throughout. In June birds it is black or dusky. Indefatigable: October, light-colored or parti-colored; November, a few black billed, mostly parti-colored; January, all black; July, all light colored. Albemarle: March and April, black; November, parti-color. Narborough: April, black. Chatham: September and October, light colored or partly dusky; January and February, black; July, September and October, light colored or parti-colored. Charles: From February to the middle of May, black; June to middle of October almost uniformly light colored.

The correlation between black bill and period of breeding activity can be verified by reference to Gifford's (1919, pp. 228-230) published field observations upon this same collection.

It will be noted that I have synonymized under *fortis* a number of other described forms, to a greater extent than has been done by anyone previously. This was by no means in attempted corroboration of any preconceived idea of my own, for the extremes of variation in the series here assembled under one name are so great as to make it seem a matter of course at first glance that there must be several distinct forms involved. With that conviction firmly in mind I spent a great deal of time in attempts to apply previously published descriptions of the various species and subspecies here synonymized to restricted series from one island or another, and, that failing, in efforts to formulate definitions of my own that would serve the same purpose. It was with considerable reluctance that I finally accepted the apparently inevitable conclusion that just one form, a widely variable one, was included under the many proposed names. The differences involved are mostly in size and shape of bill, to a slight degree in other measurements.

Geospiza fortis was described by Gould (1837, p. 5) from the Galapagos Islands, later (1841, p. 101) restricted to "Charles and Chatham islands." The type locality has latterly been regarded as Charles Island (see Sharpe, 1888, p. 10). *Geospiza dubia*, described by Gould (1837, p. 6) from the Galapagos Islands, was later (1841, p. 103) restricted to Chatham Island. These two forms have, I believe, been accepted by all subsequent writers either as distinct species or as two subspecies. The differences between them are described as consisting in larger size with relatively larger bill in *dubia*, smaller size in *fortis*, and in variously

described minor differences in shape of bill. *Dubia* has been restricted to Chatham, Barrington and Duncan; to *fortis* has been ascribed a range including those islands and many others.

Now, it is quite possible to pick out from among Chatham Island birds a series of large billed specimens and a series of small billed ones, and if intermediates should chance to be absent these extremes are so different as to justify their being regarded as distinct forms.

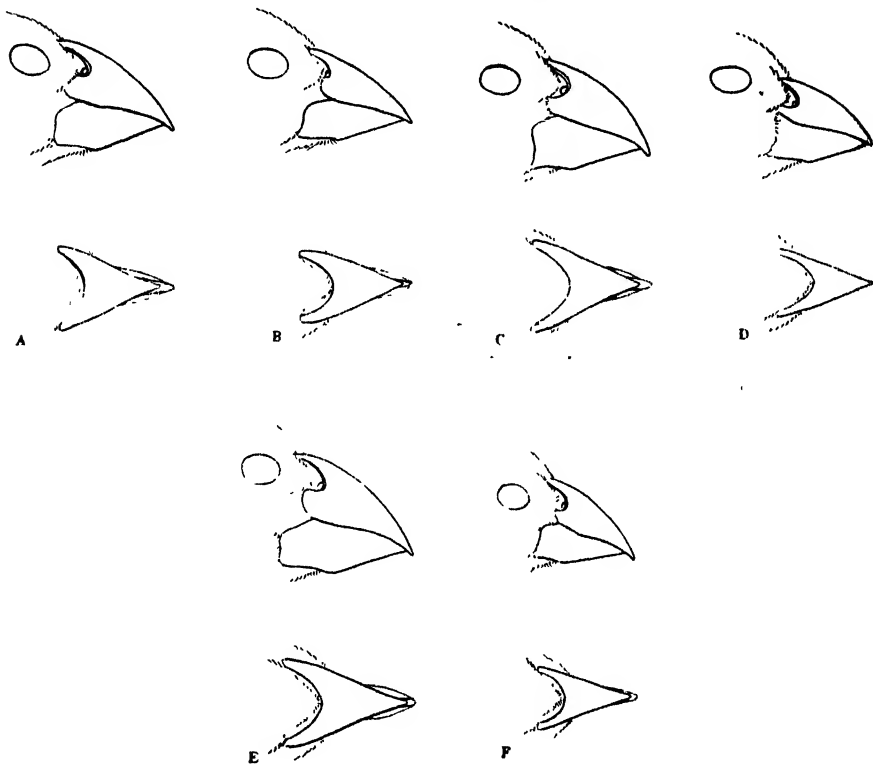


Fig. 24. *Geospiza fortis*, males, showing range of variation upon different islands: a (no. 5341), b (no. 5391), Chatham; c (no. 5150, coll. Stanford Univ., type of *Geospiza f. platyrhyncha*), d (no. 5237), Albemarle; e (no. 5161), f (no. 5412), Charles. Natural size.

I did just this thing in my preliminary examination of Chatham Island birds. Unfortunately there were still doubtful intermediates to be allocated, and these in our large series were so numerous and bridged the gap so absolutely as to make it impossible to draw any dividing line. Exactly the same condition prevails

on some of the other large islands. (See tables, pp. 158-160). This, to my mind, precludes the possibility of recognizing the form *dubia*.

Three forms have been ascribed to Albemarle, *fortis*, *albemarlei* (Ridgway, 1894, p. 362), and *platyrhyncha* (Heller & Snodgrass, 1901, p. 75). The last mentioned writers regard *albemarlei* as a

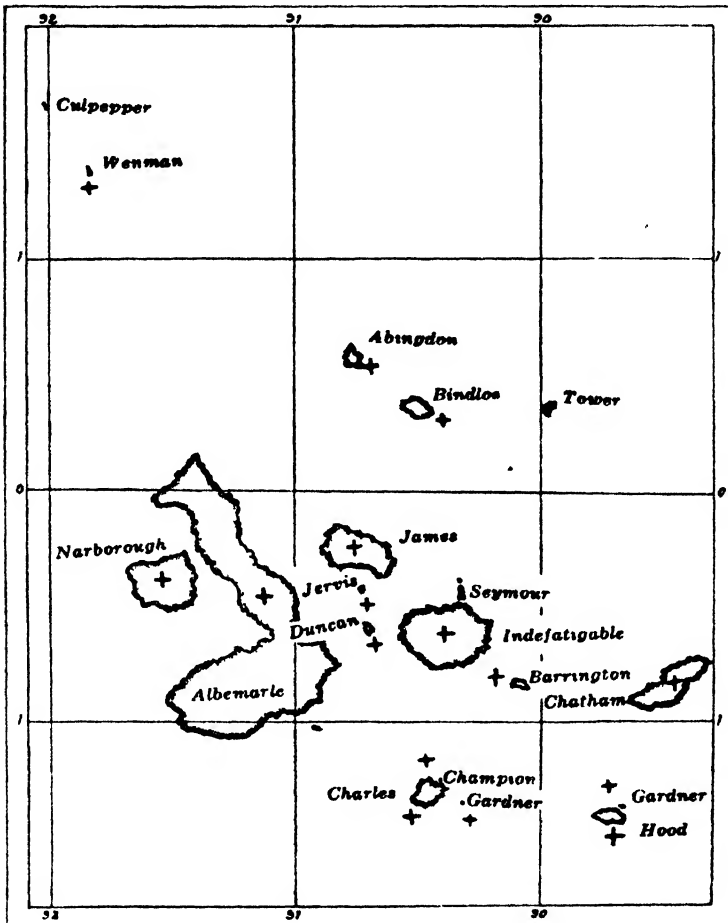


Fig. 25. Map showing distribution of *Geospiza fortis*. Symbols indicate islands where recorded.

synonym of *fortis*, so just two forms are ascribed to Albemarle by any one author. Rothschild & Hartert. (1899, p. 160), it may be pointed out, treat *albemarlei* as a subspecies of *G. dubia*, an action that shows, incidentally, the extreme similarity of *fortis*

and *dubia*. It is altogether a very pretty tangle of names! The actual situation upon Albemarle is not as clear as upon some of the other islands, for the differences described by Heller & Snodgrass as distinguishing *fortis* and *platyrhyncha* do exist, and they can to some extent be correlated with different localities upon the island. Briefly, *fortis* is regarded as a small billed form, found

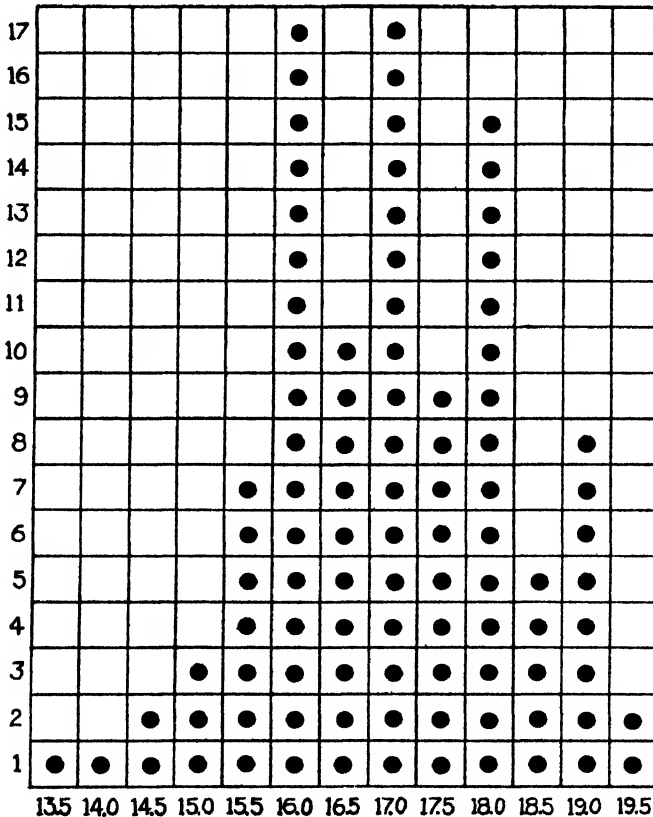


Fig. 26. Length of culmen in 97 male specimens of *Geospiza fortis* from Albemarle. Each symbol represents a specimen. Numerals at left of diagram indicate number of specimens; numerals at bottom, length of culmen in millimeters.

upon the northern end of the island (specifically, at Tagus Cove), *platyrhyncha* as a large billed form from the southern end (at and near Iguana Cove). It may be admitted that in our series most of the birds from north Albemarle are small billed, and

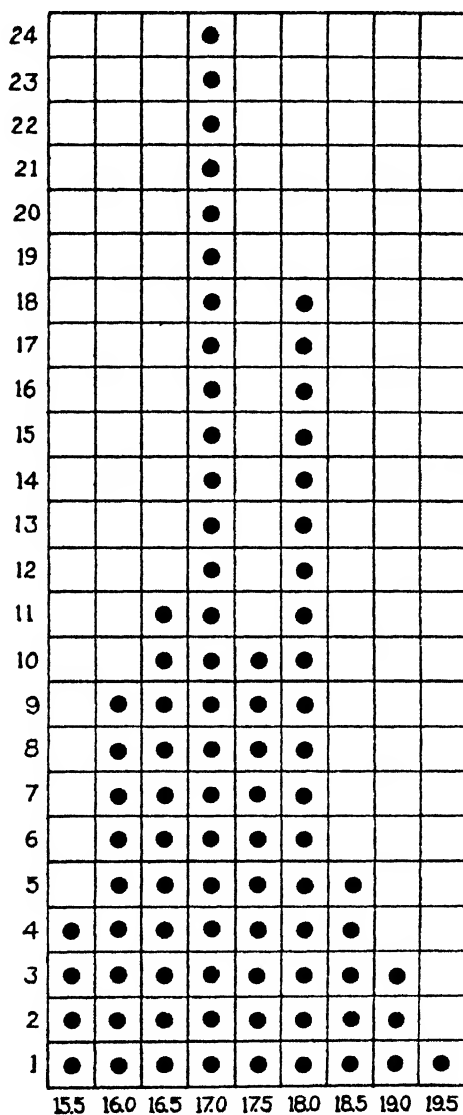


Fig. 27. Length of culmen in 85 male specimens of *Geospiza fortis* from Chatham. Each symbol represents a specimen. Numerals at left of diagram indicate number of specimens; numerals at bottom, length of culmen in millimeters.

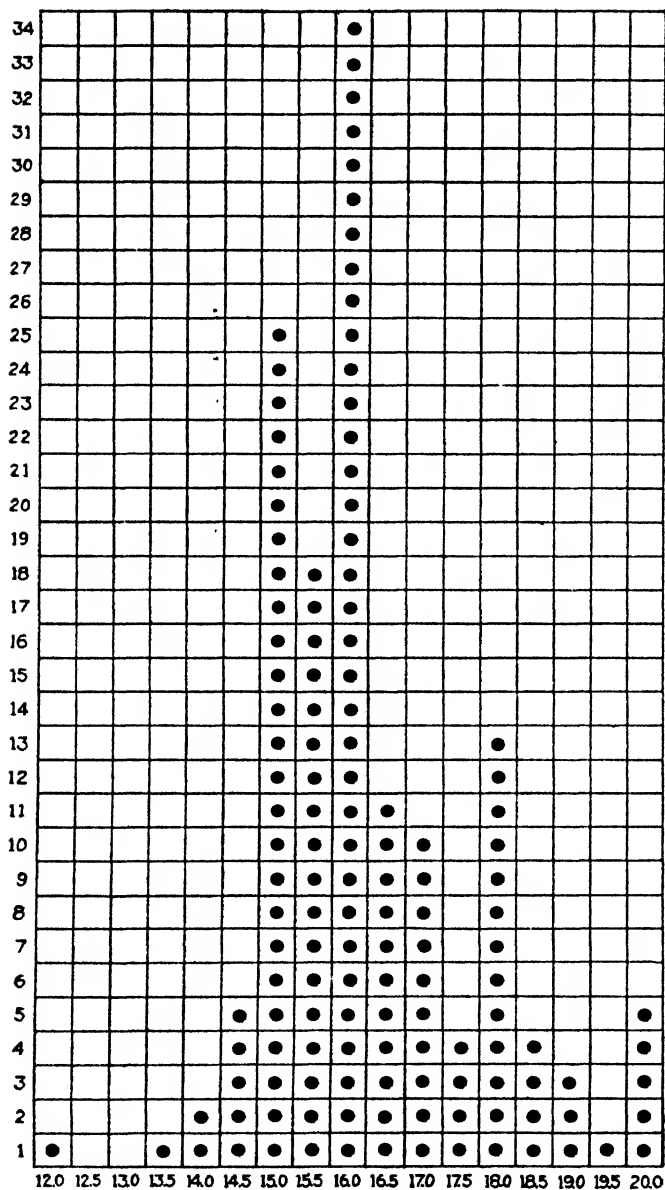


Fig. 28. Length of culmen in 137 male specimens of *Geospiza fortis* from Charles. Each symbol represents a specimen. Numerals at left of diagram indicate number of specimens; numerals at bottom, length of culmen in millimeters.

most of those from south Albemarle are large billed. Furthermore, the mode of the birds from the north end (distinctly small billed) is very similar to the modes on Narborough and James, neighboring islands near the northern portion of Albemarle; and the mode of the birds from south Albemarle (distinctly large billed) is close to that upon Charles, immediately to the southward (see table, p. 165). At the same time, there is upon Albemarle such a range of measurements in series from any one point, caused by a relatively few large billed birds in north Albemarle and a relatively few small billed birds in south Albemarle, as to cause an extensive overlapping in measurements in series from the two regions. Thus, no division can be made on geographical grounds. Individual variation throughout the island is about the same as on Chatham and Charles, making it out of the question to establish dividing lines based on measurements alone. It might be argued that the relatively few exceptional birds in the series from the two extremes of the island were migrants from the opposite ends, but there is no evidence at hand to support this view. On the whole, despite the diversity of bill structure, and admitting the apparent tendency toward geographical segregation of the two extremes, it is not feasible to define more than one form of *fortis* upon Albemarle Island.

Geospiza fratercula (Ridgway, 1894, p. 363) was described from Abingdon Island, based upon possession of a supposedly smaller bill than in *fortis*. The range was later extended to include Bindloe Island. It is recognized as a subspecies of *fortis* by Rothschild & Hartert (1899, p. 161), and by Snodgrass & Heller (1904, p. 326), but on a basis of generally smaller size and shorter wing, rather than on size of bill. In the series now available the lesser wing measurement is verified to this extent, that the birds from Abingdon include some individuals with the shortest wing measurements found in *fortis* from any locality. The extremes, however, are nearly reached in individuals from distant islands, and overlapping measurements preclude any satisfactory definition of the form *fratercula*. There are no bill differences.

Geospiza nebulosa, *G. denti-rostris*, *G. bauri*, *G. dubia simillima*, and *Cactornis brevirostris* were all based upon single birds or perhaps on three or four specimens, they have not been recognized by others subsequent to the descriptions, and our own extensive series do not bear out the existence of any such forms. I have

seen them all and regard them all as variants of the extremely unstable *Geospiza fortis*. Some of these names represent normal variation such as I find in our own series. The one known specimen of "*Cactornis brevirostris*" is an extreme departure from the mode of *fortis*, but nevertheless to be regarded, I am convinced, as merely a single aberrant individual, such as may be found in our series of other species.

The bird from Charles Island that was recorded by Ridgway (1896, p. 515) as *Geospiza strenua* (U. S. Nat. Mus. no. 115905) is a male in streaked plumage, collected April 8, 1888. Although listed by Ridgway (*loc. cit.*) as "immature," it had with little doubt been breeding during the nesting season that had just closed. It is not in juvenal plumage, it is in extremely worn plumage with a few new feathers interspersed, and it is unquestionably more



Fig. 29. *Geospiza denti-rostris*, (female?); coll. British Museum no. 55.12.19.176; type; natural size. Drawing by H. Grönvold.

than a year old, as large in general dimensions and in size of bill as it would ever become. The bill is mostly black, with a pale colored area on the lower mandible. Measurements are as follows: wing 76.0 mm.; tail 42.0; culmen 20.5; gonys 12.2; depth of bill at base 18.2; width of mandible at base 13.0; tarsus 24.2; middle toe with claw 21.5. It can be closely matched in size and general appearance by specimens of *magnirostris* from Jervis and Albemarle islands. At the same time there are specimens of *fortis* from Charles Island that nearly equal it in all measurements (see table, p. 165). Taken on Jervis or Albemarle this bird would pass as a small example of *magnirostris* (and there is the possibility that it is a stray from one of those islands), but taken on Charles it can not, by itself, be accepted as proof of the regular

occurrence of *magnirostris* on that island. It seems to me to form one of the many closely graded steps that unite *fortis* and *magnirostris*, an aberrant *fortis* of unusually large size.

It may be worth repeating for the sake of emphasis, that *Geospiza fortis* is a remarkably variable form. The difference between the extremes of bill measurement among specimens from any one island is so great, as shown in the accompanying drawings, that I will probably be criticized for lumping them all under one name. I can only re-affirm that the gradation between the extremes on any one island is such as to render it impossible to make any satisfactory division of specimens into two or more definable forms, as, indeed, is shown to some extent in the accompanying tables of measurements. Here again, field observations coupled with the judicious collecting of paired birds and whole families of parents and young might be expected to yield instructive results.

Daphne is an islet between Indefatigable and James, some four miles off the north coast of Indefatigable and about 12 miles south-east of James. Our 22 specimens of *fortis* from Daphne are distinctly small-billed, as small as the Abingdon bird, and thus closely similar to the James series and dissimilar to specimens from Indefatigable. Birds from South Seymour Island, about four miles east of Daphne and but slightly separated from Indefatigable, are indistinguishable from Indefatigable specimens, as might be expected.

In general it will be seen that in *fortis* there is increase in general size of bill from the north southward. A line roughly dividing the smaller and larger birds would pass through the center of Albemarle, south of Duncan, and south of Daphne. I do not see, though, that it is possible to define these differences in terms of subspecies, or with rigidly outlined habitats, individual variation is so wide and exceptional variants relatively so numerous. The large bill of the southernmost variants of *fortis* may have relation to the small bill of the southernmost *magnirostris*. Regarding the two species as one variable form, the trend of variation, large to small, could be shown as a double line, from north to south then north once more, the turning point at the southernmost Charles Island indicated by the large-billed *fortis* above described.

Our single specimen from Wenman Island, no. 5465, a streaked male collected September 24, may be regarded as a straggler to that point. It was apparently the only one seen upon the island

by this expedition, and it seems to be the first reported there by anyone. It is a large sized, large billed bird, quite different from the "*fratercula*" mode upon Abingdon and Bindloe, the nearest islands to the southeast. It can be most closely matched by specimens from Albemarle, which lies almost south of Wenman, a little farther than Abingdon. Gifford (1919, p. 230) has given other evidence of the occasional wandering of this species from island to island.

In the series available from Abingdon Island it will be noted that in this species, as in other "ground finches" occurring thereon, there is a very small proportion of high-plumaged males. The Academy series of *fortis* from Abingdon includes one black male and 14 streaked ones, while from the neighboring Bindloe Island, out of 8 males, 6 are black and one partly black.

The species has not been reported before from Hood Island and our series from that island does not show whether or not the birds were breeding there. All have pale colored bills, even the February birds, though *conirostris* then was with black bills.

SPECIMENS OF *Geospiza fortis* IN THE ACADEMY COLLECTION AND (FIGURES IN PARENTHESES) IN THE STANFORD UNIVERSITY COLLECTION

Island	Male (black)	Male (streaked)	Female	Young	Sex undetermined
Wenman		1			
Abingdon	1 (2)	14 (5)	8		(1)
Bindloe	6 (3)	2 (1)	5 (2)		1 (1)
James	8 (8)	2 (3)	10 (3)	(6)	
Jervis	1		2		
Indefatigable	15 (4)	19	31		1 (1)
Seymour	14 (1)	3	24 (1)		
Daphne	15	1	6		
Duncan	17	4	14		1
Albemarle	28 (24)	19 (6)	45 (21)	4 (1)	3 (2)
Narborough	4 (9)		3		
Barrington	3				
Charles	88 (4)	54 (1)	156 (5)	55 (1)	13
Gardner-near-Charles		2			
Champion		1			
Chatham	35 (4)	17 (2)	38 (1)	1 (1)	3 (1)
Hood		3	8		
Gardner-near-Hood			3		

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM) OF *Geospiza fortis*

MALES

Number of specimens	Island	Wing	Tail	Culmen	Gonyx	Depth of bill at base	Width of mandible at base	Tarsus	Middle toe with claw
10	Abingdon	65.0 (61.0-71.0)	40.3 (37.0-44.5)	15.8 (15.0-17.0)	8.5 (7.5-9.0)	11.5 (10.2-12.5)	9.4 (8.5-10.5)	20.1 (19.0-21.5)	17.6 (16.5-19.0)
10	Bindloe	65.8 (64.0-68.0)	40.1 (38.0-42.5)	16.2 (15.2-17.2)	8.6 (8.0-9.2)	12.0 (11.5-12.8)	9.2 (9.0- 9.8)	19.7 (19.0-20.5)	17.1 (16.5-18.0)
10	James	69.8 (68.0-72.0)	42.8 (41.0-46.0)	16.3 (14.0-17.5)	8.7 (8.0-9.2)	12.5 (10.0-14.0)	9.6 (8.0-10.2)	21.7 (21.0-23.5)	18.9 (17.5-21.0)
10	Narborough	69.4 (67.0-72.0)	41.6 (38.0-45.0)	16.3 (14.8-17.2)	8.8 (8.2-9.5)	12.0 (11.0-13.0)	9.4 (9.0-10.0)	21.1 (20.0-22.2)	18.3 (17.5-19.5)
10	s. Albemarle	69.6 (66.0-74.0)	42.5 (38.5-48.0)	16.1 (14.8-18.5)	8.6 (7.8-9.5)	12.2 (11.0-14.5)	9.5 (8.5-12.0)	21.3 (20.0-22.8)	18.5 (17.0-20.5)
10	n. Albemarle	74.2 (71.0-77.2)	45.4 (42.2-49.0)	18.2 (15.8-19.8)	9.8 (8.5-11.0)	14.2 (12.2-16.2)	10.9 (9.0-11.5)	22.4 (21.0-24.5)	20.2 (18.0-22.8)
10	Daphne	65.8 (63.2-68.0)	40.4 (35.0-42.5)	14.4 (13.0-15.8)	8.2 (7.5- 8.8)	10.4 (9.0-12.0)	8.1 (7.5- 8.8)	20.7 (20.0-21.2)	17.8 (16.5-19.0)
10	Seymour	69.6 (66.0-73.0)	43.4 (41.8-46.5)	16.5 (16.0-16.6)	8.7 (8.0-9.2)	11.9 (10.2-13.0)	9.3 (8.2-10.0)	21.5 (20.5-22.0)	19.9 (17.8-20.0)
16	Indefatigable	71.2 (63.5-79.0)	43.2 (40.0-47.0)	17.4 (16.0-19.5)	9.2 (8.5-11.0)	13.5 (11.0-16.5)	10.3 (8.6-12.5)	21.3 (20.0-24.6)	19.4 (17.5-20.0)
10	Duncan	66.4 (64.2-71.5)	42.1 (40.0-44.8)	15.0 (14.0-17.5)	8.1 (7.5- 8.8)	11.2 (10.0-13.0)	8.5 (8.0-10.5)	21.1 (19.5-23.0)	19.0 (17.5-21.0)
23	Charles	72.5 (68.0-78.0)	44.5 (40.0-48.5)	16.7 (14.0-20.2)	9.2 (7.5-11.0)	12.7 (11.0-16.0)	10.0 (9.5-12.5)	22.1 (20.0-24.0)	19.2 (17.2-21.5)
26	Chatham	72.6 (68.0-76.0)	44.8 (40.0-47.0)	17.6 (16.5-19.5)	9.5 (9.0-10.5)	13.7 (11.8-16.2)	10.8 (9.5-12.5)	22.2 (21.0-23.2)	19.3 (18.0-21.0)

FEMALES

8	Abingdon	60.9 (57.2-63.5)	38.0 (32.5-40.8)	14.7 (13.5-15.8)	8.2 (7.8- 8.5)	10.7 (9.5-11.5)	8.6 (7.2- 9.2)	18.8 (18.2-19.5)	16.8 (16.0-17.8)
7	Bindloe	62.5 (61.2-63.0)	37.1 (34.2-39.0)	16.9 (16.2-16.8)	8.4 (8.0- 8.8)	11.7 (11.0-12.5)	9.0 (8.5-10.0)	19.0 (18.0-19.5)	18.9 (16.0-17.5)
10	James	68.0 (64.0-74.5)	40.9 (38.2-43.0)	16.9 (14.8-17.0)	8.6 (8.0- 9.5)	11.8 (10.2-14.0)	9.3 (8.2-11.0)	20.6 (19.0-22.2)	17.5 (16.5-19.2)
3	Narborough	63.0 (65.8-70.5)	43.3 (41.5-45.0)	16.1 (15.5-17.2)	8.8 (8.5- 9.0)	12.3 (11.0-13.5)	9.3 (9.0- 9.8)	20.6 (20.2-21.0)	17.7 (17.0-19.0)
10	s. Albemarle	71.6 (68.0-75.5)	44.2 (42.0-47.2)	17.6 (16.5-18.2)	8.7 (8.0- 9.8)	12.0 (11.0-13.5)	9.6 (8.5-11.0)	21.6 (20.0-22.5)	19.1 (18.0-20.0)
10	n. Albemarle	66.9 (63.5-72.5)	40.2 (37.5-43.0)	16.0 (14.5-17.8)	8.8 (8.0-10.5)	11.6 (12.5-14.8)	10.7 (10.0-11.8)	21.9 (21.0-23.2)	19.2 (17.8-20.8)
10	Indefatigable	65.3 (62.0-68.8)	39.1 (35.2-42.0)	15.6 (14.2-16.0)	8.1 (7.2- 8.8)	10.6 (10.0-11.2)	8.5 (8.5-11.8)	21.0 (19.5-22.5)	18.7 (18.0-19.8)
10	Duncan	65.3 (62.0-68.8)	41.8 (38.0-46.5)	15.6 (14.2-18.8)	9.2 (8.0-10.2)	12.4 (10.2-13.0)	8.3 (7.8- 8.5)	20.2 (19.5-21.0)	17.5 (16.5-18.5)
10	Charles	68.3 (67.0-74.0)	41.8 (38.0-46.5)	15.6 (14.2-18.8)	9.2 (8.0-10.2)	12.4 (10.2-13.0)	9.6 (8.5-11.5)	21.8 (20.8-23.0)	19.7 (17.8-21.5)
10	Chatham	68.5 (66.0-73.0)	41.7 (39.0-44.5)	16.9 (15.0-19.2)	9.1 (8.0-10.5)	12.9 (11.0-15.5)	10.3 (9.0-11.8)	22.1 (21.2-24.0)	19.1 (17.8-21.0)

MEASUREMENTS IN MILLIMETERS OF MALE SPECIMENS OF *Geospiza fortis*
FROM INDEFATIGABLE ISLAND

Museum	No.	Age	Date	Wing	Tail	Culmen	Gonyx	Depth of bill at base	Width of mandible at base	Tarsus	Middle toe with claw
Stanford Univ.	4668	streaked	Apr. 30, 1899	63.5*	40.0*	16.0	9.0	11.0	9.0	20.0	18.5
Stanford Univ.	4702	black	Apr. 30, 1899	69.5	41.0	16.0	8.5	12.0	9.0	21.2	19.5
C. A. S.	5247	black	Nov. 18, 1905	70.0	44.0	16.0	8.5	12.0	9.2	21.0	18.5
C. A. S.	5392	black	Nov. 7, 1905	70.0	43.5	16.2	8.5	11.2	9.2	20.5	19.0
C. A. S.	5301	black	July 23, 1906	70.5	42.0	16.5	8.5	12.0	9.5	22.0	19.2
C. A. S.	5509	streaked	Nov. 18, 1905	66.0	41.0	17.0	9.2	12.2	10.0	22.0	18.0
Stanford Univ.	4667	black	Apr. 30, 1899	68.0	40.0	17.0	8.5	12.0	8.5	22.0	17.8
C. A. S.	5475	streaked	Nov. 18, 1905	68.5	43.5	17.0	9.2	13.0	10.2	22.0	19.2
Stanford Univ.	4707	black	Apr. 30, 1899	68.5	40.0	17.5	9.0	12.5	10.0	22.0	20.0
C. A. S.	5295	black	Nov. 13, 1905	72.0	44.5	17.5	9.2	13.0	10.8	21.2	19.0
C. A. S.	6780	black	Jan. 12, 1906	74.2	46.0	18.0	9.5	15.0	12.0	22.5	20.5
C. A. S.	5462	streaked	Nov. 20, 1905	76.0	44.5	18.5	9.5	14.2	11.0	23.0	20.5
C. A. S.	5336	black	Nov. 3, 1905	77.0	47.0	19.0	10.0	15.5	12.0	23.5	21.0
C. A. S.	5258	black	Nov. 25, 1905	76.0	44.5	19.5	10.0	15.0	11.2	22.5	20.5
C. A. S.	5223	black	Jan. 11, 1906	79.0	47.0	19.5	11.0	16.5	12.5	24.5	20.0

*Very worn plumage

MEASUREMENTS IN MILLIMETERS OF MALE SPECIMENS OF *Geospiza fortis*
FROM CHATHAM ISLAND

Museum	No.	Age	Date	Wing	Tail	Culmen	Gonyx	Depth of bill at base	Width of mandible at base	Tarsus	Middle toe with claw
C. A. S.	5391	black	Oct. 16, 1905	70.0	47.0	16.5	9.0	12.5	9.5	21.0	19.5
C. A. S.	6772	black	Jan. 29, 1906	68.0	40.0	17.0	9.0	11.8	9.5	21.0	18.2
C. A. S.	5360	black	Jan. 29, 1906	69.2	41.2	17.0	9.0	13.0	11.0	22.0	19.2
C. A. S.	5355	black	Feb. 8, 1906	71.5	44.0	17.0	9.5	12.0	9.5	21.5	19.5
C. A. S.	5350	black	Jan. 25, 1906	71.5	45.5	17.0	9.2	13.0	10.0	23.0	21.0
C. A. S.	5405	black	Oct. 18, 1905	72.0	45.5	17.0	9.0	13.5	10.0	21.0	18.0
C. A. S.	5349	black	Feb. 9, 1906	72.5	43.0	17.0	10.0	13.2	10.2	22.5	20.0
C. A. S.	5259	black	Jan. 26, 1906	72.5	44.5	17.0	9.0	13.5	11.0	22.0	19.0
C. A. S.	5362	black	Feb. 8, 1906	73.0	44.0	17.0	9.2	13.0	10.5	22.0	19.0
C. A. S.	5170	black	Oct. 17, 1905	73.0	45.5	17.0	9.2	14.0	11.0	23.2	19.0
C. A. S.	5394	black	Oct. 16, 1905	74.0	44.0	17.0	9.2	12.2	10.0	21.2	19.5
C. A. S.	5347	black	Oct. 16, 1905	74.5	46.0	17.0	9.2	14.5	12.0	22.2	18.5
C. A. S.	5277	black	Feb. 9, 1906	70.5	41.0	17.2	9.0	14.0	11.0	22.5	18.0
C. A. S.	5352	black	Oct. 17, 1905	74.5	46.8	17.2	9.0	15.2	11.0	22.2	18.5
C. A. S.	5229	black	July 6, 1906	70.0	45.0	17.5	9.5	12.5	9.5	22.2	20.0
C. A. S.	5354	black	Jan. 29, 1906	72.0	46.0	17.5	9.5	13.5	11.0	21.5	19.0
C. A. S.	5370	black	Feb. 13, 1906	72.8	44.0	17.5	9.5	13.2	10.2	21.5	18.5
C. A. S.	5172	streaked	Oct. 16, 1905	74.2	47.0	17.8	10.0	15.0	12.0	23.0	21.0
C. A. S.	5173	streaked	Sept. 10, 1906	72.5	47.0	18.0	10.0	15.5	11.5	22.2	20.0
C. A. S.	5339	black	Jan. 29, 1906	75.2	44.8	18.0	9.5	14.0	11.5	23.0	19.5
C. A. S.	5169	black	Jan. 26, 1906	76.0	44.8	18.0	10.0	14.0	11.2	22.0	19.5
C. A. S.	5344	black	Sept. 8, 1906	72.2	46.0	18.5	9.8	14.8	12.0	23.0	19.0
C. A. S.	5377	black	Jan. 29, 1906	76.0	45.5	18.5	10.0	14.2	12.2	23.2	19.2
C. A. S.	5171	black	Jan. 27, 1906	74.0	46.5	19.0	10.0	16.2	12.5	23.2	19.0
C. A. S.	5341	black	Jan. 25, 1906	75.2	45.5	19.0	10.0	14.8	11.5	22.5	20.0
Stanford Univ.	4859	black	May 23, 1899	70.0	45.5	19.5	10.5	14.5	11.0	22.0	20.0

MEASUREMENTS IN MILLIMETERS OF MALE SPECIMENS OF *Geospiza fortis*
FROM CHARLES ISLAND

Museum	No.	Age	Date	Wing	Tail	Gonyx	Depth of base of mandible	Tarsus	Middle toe with claw
C. A. S.	5216	black	Feb. 28, 1906	73.0	43.0	7.5	11.0	20.0	18.5
C. A. S.	5397	black	Oct. 11, 1905	68.5	44.0	8.5	11.0	21.0	18.5
C. A. S.	5412	black	Mar. 1, 1906	70.0	44.5	15.0	11.0	21.0	17.2
C. A. S.	5419	black	Mar. 1, 1906	71.0	42.0	8.2	11.2	22.0	18.0
C. A. S.	5358	black	Oct. 10, 1905	71.0	44.0	8.5	11.5	20.2	19.0
C. A. S.	5265	black	Mar. 1, 1906	72.0	44.5	15.0	11.0	20.0	18.2
C. A. S.	5401	black	Mar. 2, 1906	73.0	43.5	9.0	11.5	22.0	19.0
C. A. S.	5331	black	Mar. 1, 1906	68.0	41.0	8.2	11.2	22.0	18.5
C. A. S.	5359	black	May 23, 1906	70.5	40.0	15.5	11.0	21.5	17.2
C. A. S.	5393	black	Oct. 9, 1905	72.5	45.5	15.5	12.0	22.0	19.0
C. A. S.	5199	black	June 4, 1906	70.0	45.0	9.0	12.0	21.0	19.0
C. A. S.	5255	black	Mar. 1, 1906	71.2	41.5	16.0	12.2	22.2	18.5
C. A. S.	5298	black	May 31, 1906	70.2	43.0	9.2	11.8	22.5	19.5
C. A. S.	5269	black	Oct. 12, 1905	74.0	44.2	17.5	13.0	24.0	20.0
C. A. S.	5345	black	June 4, 1906	75.5	44.5	17.5	14.5	23.0	20.0
C. A. S.	5346	black	June 2, 1906	75.0	46.5	17.8	13.0	23.0	20.2
C. A. S.	5351	black	May 28, 1906	73.5	44.0	10.5	14.2	23.0	19.5
C. A. S.	5214	black	Oct. 5, 1905	74.0	48.5	18.0	14.0	22.2	20.2
C. A. S.	5243	black	May 31, 1906	74.0	48.5	18.2	15.0	24.0	19.0
C. A. S.	5260	black	Oct. 5, 1905	73.2	48.5	19.0	15.0	23.0	20.0
C. A. S.	5227	black	May 28, 1906	74.5	42.0	19.8	15.0	23.0	20.5
C. A. S.	5371	black	Oct. 9, 1905	75.2	47.0	19.8	14.0	23.5	21.0
C. A. S.	5161	streaked	Oct. 5, 1905	78.0	48.0	20.2	16.0	23.0	21.5
<i>"Cactornis brevirostris"</i>									
U. S. Nat. Mus. 115920*		black	April 8, 1888	68.0	42.5	9.8	11.5	21.5	19.8

*Type

74. *Geospiza fuliginosa fuliginosa* Gould

- Geospiza fuliginosa* Gould, 1837a, p. 5 (orig. descr.; Galapagos Islands); 1841, p. 101 ("Chatham and James islands").—Sclater & Salvin, 1870, p. 323 (Indefatigable).—Sundevall, 1871, p. 125.—Salvin, 1876, p. 482, figs.—Sharpe, 1888, p. 12.—Ridgway, 1890, p. 107; 1897, p. 526; 1901, p. 504.—Rothschild, 1902a, p. 46 (Chatham Id., nest and eggs).—Gifford, 1919, p. 231, part.
- Geospiza fuliginosa fuliginosa* Rothschild & Hartert, 1899, p. 161; 1902, p. 394.—Snodgrass & Heller, 1904, p. 315 (Chatham Id.).
- Geospiza parvula* (not of Gould) Sundevall, 1871, p. 125.—Salvin, 1876, p. 482, figs.—Sharpe, 1888, p. 13.
- Geospiza fuliginosa parvula* Snodgrass & Heller, 1904, p. 294.
- Geospiza harterti* Ridgway, 1901, p. 507 (orig. descr.; Chatham Id.).

GEOSPIZA FULIGINOSA Gould

Cotype.—British Museum, no. 55.12.19.44; (♂ ad.; Galapagos Islands); received from Zoological Society of London.

Cotype.—British Museum, no. 57.11.28.247; (♂ ad.; Galapagos Islands); received from J. Gould.

Cotype.—British Museum, no. 85.12.14.320; (♀?; Galapagos Islands); Charles Darwin.*

Cotype.—British Museum, no. 37.2.21.410; (♀?; Galapagos Islands); received from Burnett and Fitzroy.

Cotype.—British Museum, no. 37.2.21.411; (♀?; Galapagos Islands); received from Burnett and Fitzroy.

Number 55.12.19.44 is apparently the specimen that was indicated by Sharpe (1888, p. 13) as "type of species", and it now bears a red "type label".

GEOSPIZA HARTERTI Ridgway

Type.—Rothschild Museum; ♂ ad.; Chatham Island; September 8, 1891; "Dr. G. Baur coll., ex spirits."

In my opinion this specimen with others in the Rothschild Museum similarly labelled (Albemarle 2, Crossman 14, Hood 1, Daphne 3, Charles 1, Gardner-near-Charles 2) form a series of intermediates between *fortis* and *fuliginosa*, nearer the latter, perhaps, and not a distinguishable species or subspecies.

DESCRIPTION.—Differs from *Geospiza fortis* in smaller size and disproportionately smaller bill (see measurements, p. 175). Coloration and plumage stages as in *fortis* and *magnirostris* (see description of *G. magnirostris*, p. 144).

*Ex Salvin-Godman coll. (purchased from T. C. Eyton coll.); purchased by Eyton at Zoological Society's sale. All the Galapagos birds in the Zoological Society collection were collected by Darwin. N.B.K.

HABITAT.—All of the central and southern islands of the Galapagos Archipelago. Explicitly, it has been found on James, Jervis,

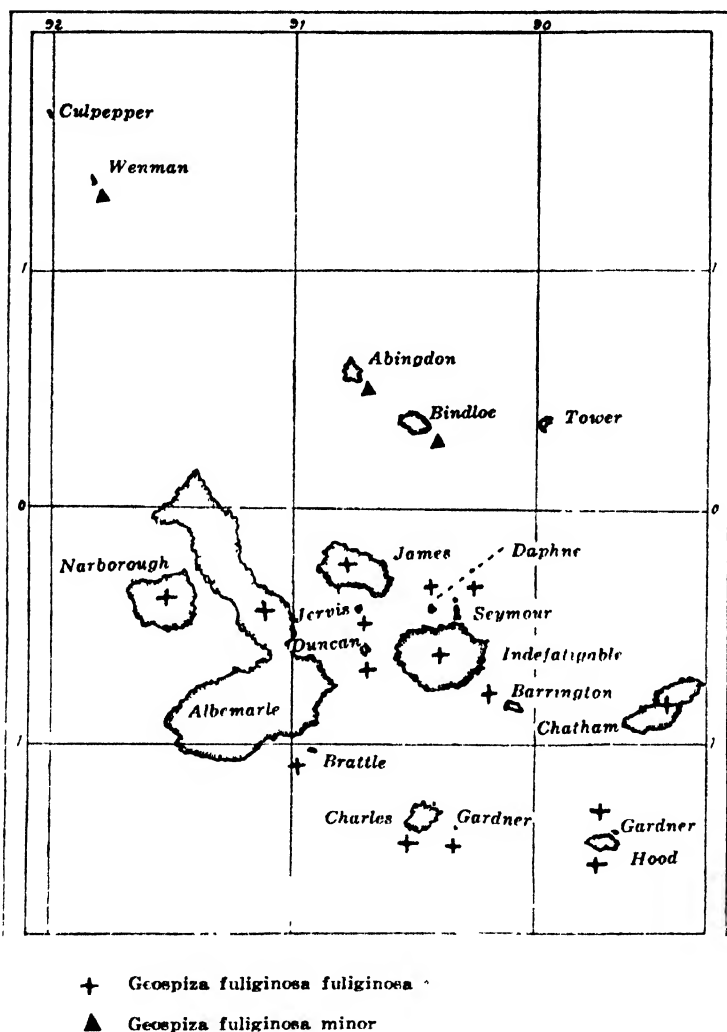


Fig. 30. Map showing distribution of subspecies of *Geospiza fuliginosa*. Symbols indicate islands where recorded.

Indefatigable, Seymour, Daphne, Duncan, Albemarle, Narborough, Brattle, Barrington, Charles, Gardner-near-Charles, Enderby, Hood, Gardner-near-Hood, and Chatham.

There are at hand 645 skins in the Academy collection* and 107 in the Stanford University collection, as shown in the accompanying table. They were collected on the several islands at seasons as follows: James, December, January, April; Jervis, December; Indefatigable, January, April, July, October, November; Seymour, April, May, July, November; Duncan, May, August, December; Albemarle, January, February, March, April, May, August, September, October, November, December; Narborough, January, March, April; Brattle, October; Barrington, May, July, October; Charles, February, March, May, June, October; Gardner-near-Charles, October; Enderby, May; Hood, January, February, May, June, July, September, October; Gardner-near-Hood, May, September; Chatham, January, February, May, July, September, October.

Variation in bill color is about as follows. In adults taken late in November and early in December the bill is mostly pale colored, often partly dusky, and occasionally black. From late December until early May it is entirely black with hardly an exception. In most of the birds taken late in May it is parti-colored, with pale bills beginning to predominate. From the latter part of June until late in September it is pale colored. Most October birds have the bill pale colored, but in a very few it is dusky or parti-colored. This variation occurs similarly in black males, in adult streaked males, and in adult females. It is less apparent in the series of streaked birds (male and female) as such series include many immature birds in the plumage following the juvenal, and in all these the bill is pale colored. Comparison of this variation with the data given by Gifford (1919, pp. 231-235) pertaining to breeding activities will show how closely the periods of acquisition and loss of black color in the bill correspond with the waxing and waning of the reproductive period.

There are birds in juvenal plumage at hand collected on Albemarle during April (April 11-26), and on Charles between May 16 and June 1. The annual molt of the adult appears to be accomplished between the middle of April and the end of June; the post-juvenal molt probably occurs at about the same time.

*The Academy series of *Geospiza fuliginosa* are catalogued under the following numbers. *G. f. fuliginosa*: nos. 5424-5430, 5607-5761, 5763-5813, 5815-5861, 5863-5901, 5903-5926, 6308-6379, 6381-6522, 6524-6565, 6567-6575, 6577-6662, 6815, 6817-6832, 6834-6862, 6864-6868, 6919, 8042.

G. f. minor: nos. 5481-5482, 5862, 5927-5941, 5952, 6380, 6523, 6566, 6663-6675, 6859-6862.

Fuliginosa is one of the most widely spread of any of the *Geospizidæ*. It occurs over a greater number of islands than does any other species except *fortis* and with less variation as between different islands. It is also one of the most abundant species. Gifford (1919, p. 231) says that it is "the commonest of all the Galapagos birds, being found on every island and islet visited, except Culpepper". At the same time the amount of variation exhibited from any one island (or at any rate from several of the islands) is such as to afford justification for the action of earlier students of Galapagos birds in assuming that there were two species represented. In our large series from Chatham Island in particular, it seemed at first an easy and obvious thing to do, to effect a division on the score of size, and the differences between extremes was such as to make it seem impossible that they should

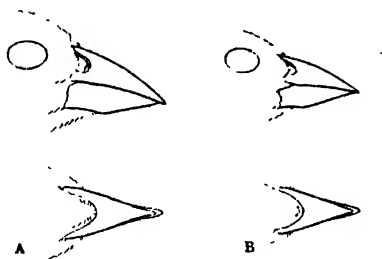


Fig. 31. *Geospiza fuliginosa*, males: a, *G. f. fuliginosa* (no. 5871), Chatham; b, *G. f. minor* (no. 5939), Abingdon. Natural size.

all be of one form. In the accompanying table of measurements (p. 175) two series of black males from Chatham Island are entered to illustrate the range of size between the extremes. Overlapping of every measurement occurs, however, so that it is not possible to draw any line between.

A supposedly smaller form to which the name "*parvula*" has been applied has received recognition from some quarters, notably of late from Snodgrass & Heller (1904, p. 294). It should be pointed out first that the name *Geospiza parvula* Gould is applicable, not to a form of *G. fuliginosa*, but to the bird later named *Camarhynchus prothemelas* Sclater & Salvin (see p. 229). At any rate, I am not able to define or allocate two forms of *Geospiza fuliginosa* on the central and southern islands. Snodgrass & Heller restrict the habitat of *G. fuliginosa fuliginosa* to Chatham Island.

75. *Geospiza fuliginosa minor* Rothschild & Hartert

Geospiza fuliginosa minor Rothschild & Hartert, 1899, p. 162 (orig. descr.; Bindloe and Abingdon islands); 1902, p. 395 (nest and eggs).—Snodgrass & Heller, 1904, p. 316.—Hartert, 1919, p. 152 (particulars of type specimen, in Rothschild Museum).

Geospiza minor Ridgway, 1901, p. 506.

Geospiza parvula (not of Gould) Sclater & Salvin, 1870, p. 323.—Salvin, 1876, p. 483, part.—Sharpe, 1888, p. 14, part.—Ridgway, 1890, p. 107; 1897, p. 529, part.

GEOSPIZA FULIGINOSA MINOR Rothschild & Hartert

Type.—Rothschild Museum; ♂ ad.; Bindloe Island; September 5, 1891; "Dr. Baur coll. Ex spirits."

DESCRIPTION.—Differs from *Geospiza fuliginosa fuliginosa* in slightly smaller general size and in smaller bill (see text, beyond, and measurements, p. 175).

HABITAT.—Wenman, Abingdon, and Bindloe islands.

The material at hand consists of 39 skins in the Academy collection, collected on Wenman, Abingdon, and Bindloe, September 17 to 24; and 7 from the Stanford University collection taken on Abingdon and Bindloe, June 20 to 25. The Wenman birds have light colored bills; they appear to be all immature. Of those from Abingdon, the June birds have the bill mostly blackish or dusky, the September birds have the bill black in all that can be recognized as adult. Of the Bindloe series, the June specimens have the bill black or dusky, in the September skins (both black and streaked) the bill is uniformly pale colored. In the Abingdon Island September series some of the birds (with black bill) are marked as being in breeding condition, and there are in the series young birds just out of the nest. It would appear that nesting was in progress on Abingdon during September, but not on Bindloe.

This is perhaps as faintly characterized a form as any in the family that is distinguished by a separate name. Differences, as compared with *G. f. fuliginosa*, consist of slightly smaller general size and rather lighter bill. In every measurement there is extensive overlapping with *fuliginosa*: on Chatham Island in particular there are many birds that are as small as *minor* (see table of measurements). It is perhaps desirable to continue the form under a separate subspecific name so as to emphasize the existence of the tendency to small size, but the ascribed characters can hardly be regarded other than as tendencies in the described direction.

It is worthy of notice that in our Abingdon series of 27 skins there is only one black male, though many of the streaked males are adult and in breeding condition. From no other island is there such a small proportion of black males. (See Rothschild & Hartert, 1899, p. 162.) It is a curious fact that this bird should have been breeding on Abingdon in September, the nesting season elsewhere in the archipelago appearing to lie between November and April.

Apparently the Academy expedition was the first to report this species from Wenman Island.

SPECIMENS OF THE *Geospiza fuliginosa* GROUP IN THE ACADEMY COLLECTION AND
(FIGURES IN PARENTHESES) IN THE STANFORD UNIVERSITY COLLECTION

Name	Island	Male (black)	Male (streaked)	Female	Young	Sex undetermined
<i>Geospiza f. minor</i>	Wenman		1	3		
<i>Geospiza f. minor</i>	Abingdon	1 (3)	12 (1)	10	2	2
<i>Geospiza f. minor</i>	Bindloe	5 (3)	1	2		
<i>Geospiza f. fuliginosa</i>	James	5 (1)	1 (1)	3 (4)	(4)	2
<i>Geospiza f. fuliginosa</i>	Jervis	5	2			
<i>Geospiza f. fuliginosa</i>	Indefatigable	19 (6)	11 (1)	30		3 (1)
<i>Geospiza f. fuliginosa</i>	Seymour	8 (18)	5 (2)	11 (8)		
<i>Geospiza f. fuliginosa</i>	Daphne		1			
<i>Geospiza f. fuliginosa</i>	Duncan	31 (3)	22	23 (1)		(2)
<i>Geospiza f. fuliginosa</i>	Albemarle	33	17	36	5	1
<i>Geospiza f. fuliginosa</i>	Narborough	2 (13)		(8)		(2)
<i>Geospiza f. fuliginosa</i>	Brattle	4	2	4		
<i>Geospiza f. fuliginosa</i>	Barrington	22 (6)	1 (1)	4 (2)		
<i>Geospiza f. fuliginosa</i>	Charles	23 (2)	23 (5)	71	15	11
<i>Geospiza f. fuliginosa</i>	Gardner-near-Charles	2	1			
<i>Geospiza f. fuliginosa</i>	Enderby	1			2	
<i>Geospiza f. fuliginosa</i>	Hood	17 (3)	2 (1)	11 (1)		1 (1)
<i>Geospiza f. fuliginosa</i>	Gardner-near-Hood	4	2 (1)	5		1
<i>Geospiza f. fuliginosa</i>	Chatham	40 (4)	28 (1)	85 (4)		2

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM) OF THE
SUBSPECIES OF *Geospiza fuliginosa*

MALES

Number of specimens	Name	Island	Wing	Tail	Culmen	Gonys	Depth of bill at base	Width of mandible at base	Tarsus	Middle toe with claw
1	<i>Geospiza f. minor</i>	Wenman	59.0	40.5	11.5	6.0	8.2	6.2	19.0	16.0
10	<i>Geospiza f. minor</i>	Abingdon	57.9 (55.2-60.0)	36.1 (34.0-39.0)	11.1 (10.0-12.5)	6.3 (6.0-7.0)	7.4 (6.5-8.2)	6.1 (6.0-6.5)	18.0 (17.0-19.0)	15.2 (14.5-16.0)
9	<i>Geospiza f. minor</i>	Bindloe	57.8 (55.2-59.2)	36.4 (36.0-37.0)	11.0 (10.2-11.2)	6.2 (6.0-6.5)	7.0 (6.2-7.8)	6.0 (5.8-6.5)	18.2 (18.0-19.0)	15.2 (14.2-16.0)
7	<i>Geospiza f. fuliginosa</i>	James	61.8 (58.0-64.2)	37.6 (35.5-42.0)	11.3 (10.2-12.0)	6.5 (6.2-6.8)	7.9 (7.5-8.0)	6.5 (6.2-7.0)	19.3 (18.5-20.0)	16.3 (15.0-17.0)
5	<i>Geospiza f. fuliginosa</i>	Jervis	61.7 (61.0-62.2)	37.8 (36.0-39.8)	11.8 (11.0-12.0)	6.7 (6.2-7.0)	7.8 (7.2-8.0)	6.4 (6.2-7.0)	19.5 (19.0-20.0)	16.8 (16.0-17.5)
10	<i>Geospiza f. fuliginosa</i>	Albemarle	64.2 (63.2-66.5)	40.9 (38.5-48.0)	11.8 (11.0-13.0)	6.7 (6.2-7.2)	8.2 (7.2-8.0)	6.7 (6.2-7.0)	19.8 (19.0-20.5)	16.8 (16.0-17.5)
10	<i>Geospiza f. fuliginosa</i>	Narborough	62.5 (61.5-65.0)	37.8 (36.0-40.0)	11.0 (10.0-11.5)	6.2 (6.0-6.5)	7.6 (7.2-8.0)	6.3 (6.0-7.0)	19.4 (18.5-20.5)	16.2 (15.5-17.0)
10	<i>Geospiza f. fuliginosa</i>	Duncan	62.4 (60.0-64.5)	37.9 (37.0-40.0)	11.7 (11.0-13.0)	6.7 (6.2-7.5)	7.9 (7.5-8.5)	6.3 (6.2-7.0)	19.3 (18.5-20.5)	16.5 (15.5-17.0)
10	<i>Geospiza f. fuliginosa</i>	Indefatigable	62.4 (60.5-64.5)	38.9 (37.5-41.5)	11.5 (11.0-12.0)	6.5 (6.0-7.0)	7.6 (7.2-8.2)	6.3 (6.0-7.0)	19.3 (19.0-20.5)	16.2 (15.2-17.0)
10	<i>Geospiza f. fuliginosa</i>	Barrington	62.0 (60.2-64.5)	38.3 (37.0-39.8)	12.0 (10.5-13.0)	6.8 (6.0-7.0)	7.9 (7.0-8.2)	6.5 (6.0-7.0)	19.4 (18.5-21.0)	16.4 (15.8-17.0)
10	<i>Geospiza f. fuliginosa</i>	Charles	62.2 (60.5-65.0)	39.4 (37.5-42.2)	11.2 (10.0-12.2)	6.7 (6.2-7.0)	7.8 (7.2-8.5)	6.5 (6.0-7.0)	19.8 (19.0-20.0)	16.9 (16.0-17.5)
10	<i>Geospiza f. fuliginosa</i>	Hood	63.5 (62.2-65.0)	39.9 (38.8-42.0)	11.9 (11.5-12.5)	6.9 (6.5-7.2)	7.7 (7.2-8.5)	6.6 (6.5-7.0)	19.8 (18.5-21.0)	16.8 (16.0-17.8)
10	<i>Geospiza f. fuliginosa</i>	Chatham	63.4 (61.0-65.0)	39.6 (36.5-42.0)	12.1 (10.8-13.2)	7.1 (7.0-7.5)	8.0 (7.0-8.0)	6.7 (6.5-7.2)	19.9 (19.0-20.5)	17.1 (16.0-18.0)
10	<i>Geospiza f. fuliginosa</i>	Chatham	61.1 (57.0-63.5)	36.8 (34.0-38.0)	10.5 (10.0-11.2)	6.0 (5.8-6.2)	7.1 (7.0-7.5)	5.9 (5.5-6.2)	19.3 (18.0-20.5)	15.6 (15.0-16.0)

FEMALES

3	<i>Geospiza f. minor</i>	Wenman	62.0 (57.5-67.5)	37.7 (37.0-39.5)	11.5 (11.2-12.2)	6.2 (6.0-6.5)	7.5 (7.2-8.2)	6.6 (6.2-7.0)	19.9 (19.2-20.5)	16.3 (15.8-17.0)
9	<i>Geospiza f. minor</i>	Abingdon	57.2 (54.5-60.2)	36.5 (35.8-38.0)	11.1 (10.8-11.5)	6.2 (6.0-6.5)	7.4 (7.2-8.2)	6.1 (6.0-6.5)	18.1 (16.8-19.0)	15.5 (14.0-16.5)
2	<i>Geospiza f. minor</i>	Bindloe	64.8-66.5	31.0-32.5	9.0-11.5	5.8-6.2	6.5-7.5	5.5-6.0	18.5-17.5	15.0-14.5
6	<i>Geospiza f. fuliginosa</i>	Jervis	60.8 (60.0-62.0)	37.8 (36.0-39.8)	12.3 (11.8-13.0)	6.8 (6.2-7.0)	7.9 (7.2-8.2)	6.4 (6.0-6.8)	18.9 (17.5-20.2)	16.3 (15.2-17.2)
2	<i>Geospiza f. fuliginosa</i>	Jervis	60.5-61.0	34.5-36.5	11.2-12.5	6.2-6.5	7.3-8.0	6.5-6.5	18.2-19.2	15.6-16.0
10	<i>Geospiza f. fuliginosa</i>	Albemarle	60.0 (56.2-63.2)	36.9 (35.0-40.0)	11.3 (10.2-12.3)	6.6 (6.0-7.2)	7.9 (7.2-8.2)	6.3 (6.0-6.8)	19.7 (19.2-20.2)	16.8 (16.2-18.0)
8	<i>Geospiza f. fuliginosa</i>	Narborough	61.4 (58.0-63.5)	37.9 (35.0-40.0)	11.1 (10.5-11.8)	6.5 (6.0-7.0)	7.9 (7.2-8.2)	6.2 (6.0-6.8)	19.4 (18.5-20.2)	16.4 (15.8-17.0)
10	<i>Geospiza f. fuliginosa</i>	Duncan	60.3 (55.0-63.0)	35.9 (34.2-38.5)	12.1 (11.2-12.8)	6.6 (6.2-7.0)	7.6 (7.2-8.2)	6.5 (6.0-6.8)	19.7 (18.5-20.5)	16.6 (15.2-17.5)
10	<i>Geospiza f. fuliginosa</i>	Indefatigable	59.3 (57.2-61.0)	36.5 (33.0-38.5)	12.1 (11.2-12.5)	6.7 (6.2-7.0)	7.8 (7.2-8.2)	6.5 (6.2-6.5)	19.4 (19.0-20.5)	17.1 (16.2-17.6)
6	<i>Geospiza f. fuliginosa</i>	Barrington	59.0 (57.2-61.5)	35.0 (32.5-37.0)	12.0 (11.2-12.5)	6.5 (6.2-7.0)	7.8 (7.2-8.0)	6.4 (6.2-6.5)	18.6 (18.0-19.8)	16.6 (16.2-17.5)
10	<i>Geospiza f. fuliginosa</i>	Charles	60.2 (59.5-61.5)	36.2 (34.2-38.0)	11.8 (11.0-12.8)	6.8 (6.2-7.2)	7.7 (7.0-8.0)	6.2 (6.0-6.5)	19.3 (18.2-20.3)	17.1 (16.2-18.2)
10	<i>Geospiza f. fuliginosa</i>	Hood	60.9 (58.2-62.5)	38.0 (34.2-41.0)	11.8 (11.0-12.5)	6.8 (6.2-7.0)	7.8 (7.0-8.5)	6.4 (6.0-6.8)	19.8 (17.2-20.3)	16.7 (15.2-17.5)
10	<i>Geospiza f. fuliginosa</i>	Chatham	63.8 (61.8-62.0)	37.5 (36.5-39.0)	12.6 (12.2-14.0)	6.9 (6.5-7.8)	8.0 (7.5-8.5)	6.4 (6.0-7.0)	19.5 (18.5-20.0)	17.0 (16.0-17.8)
10	<i>Geospiza f. fuliginosa</i>	Chatham	58.8 (64.0-62.0)	35.7 (32.2-39.0)	10.3 (9.5-11.0)	6.0	6.9 (6.5-7.2)	5.6 (5.2-6.0)	18.8 (18.2-19.8)	15.8 (15.0-17.0)

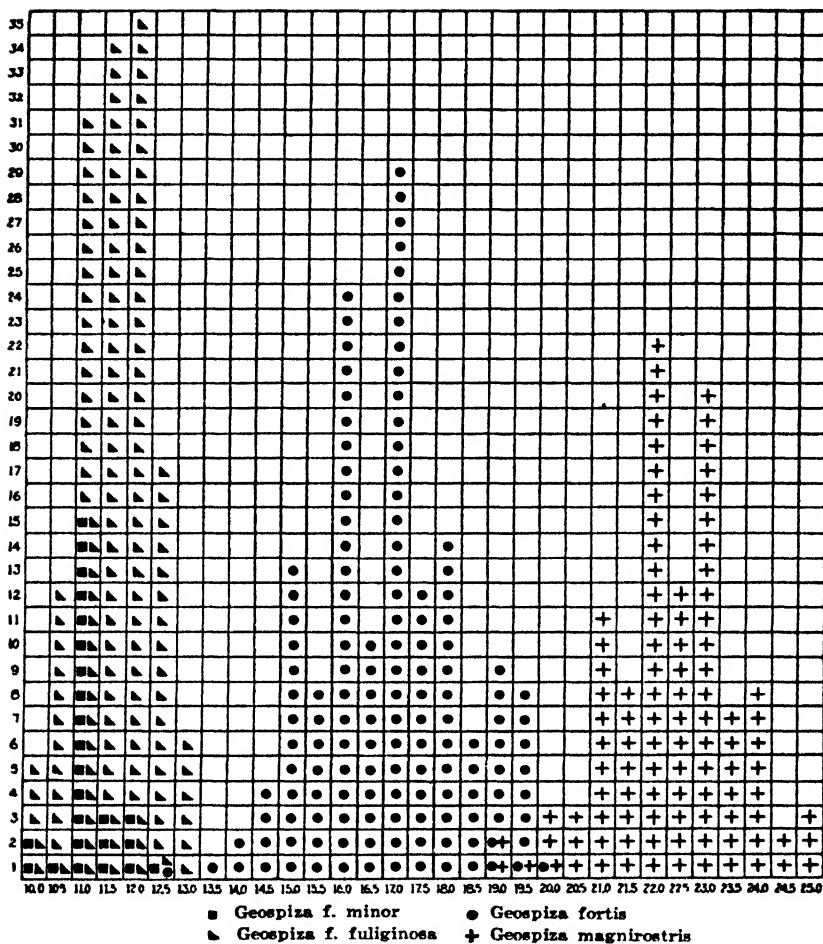
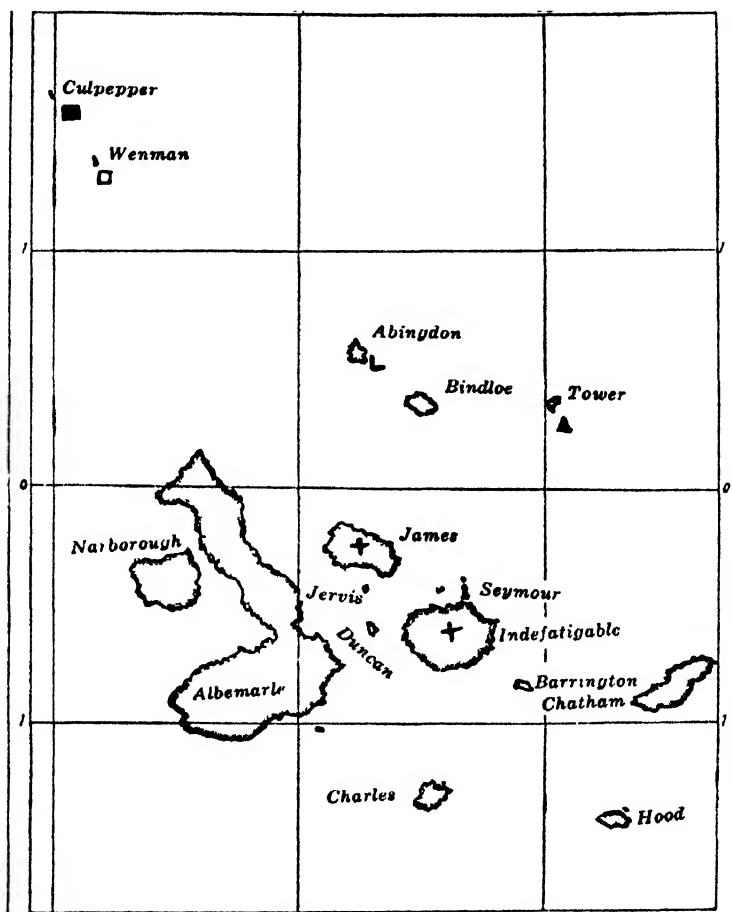


Fig. 32. Length of culmen in 25 male specimens of *Geospiza fuliginosa minor*, 140 of *G. f. fuliginosa*, 141 of *G. fortis*, and 110 of *G. magnirostris*. Each symbol represents a specimen. Numerals at left of diagram indicate number of specimens; numerals at bottom, length of culmen in millimeters.

76. *Geospiza acutirostris* Ridgway

Geospiza acutirostris Ridgway, 1894, p. 363 (Tower Id.; orig. descr.);
1901, p. 506.—Rothschild & Hartert, 1899, p. 162.

Geospiza fuliginosa acutirostris Snodgrass & Heller, 1904, p. 316.



- | | |
|--------------------------------------|--------------------------------|
| ■ <i>Geospiza s. nigrescens</i> | ▲ <i>Geospiza acutirostris</i> |
| □ <i>Geospiza s. septentrionalis</i> | ⌞ <i>Geospiza difficilis</i> |
| + | <i>Geospiza debilirostris</i> |

Fig. 33. Map showing distribution of *Geospiza acutirostris*, *G. difficilis*, *G. debilirostris*, *G. s. septentrionalis*, and *G. septentrionalis nigrescens*. Symbols indicate islands where recorded.

GEOSPIZA ACUTIROSTRIS Ridgway

Type.—Rothschild Museum; ♂ ad.; Tower Island; (no date); Dr. Baur coll.; “ex spirits.”

HABITAT.—Tower Island.

DESCRIPTION.—At the minimum of size in the genus (see measurements, p. 187). About the same size as *G. fuliginosa* but with differently shaped bill, which is notably long and acute, with culmen almost straight. *Adult male*.—Uniform black except that the under tail coverts are more or less broadly margined with white or pale buff. *Adult female*.—A dusky, streaked bird, darker than females of the *magirostris-fortis-fuliginosa* aggregation. General color dusky or blackish, usually with narrow, sometimes with fairly broad, feather edgings of pale buffy or whitish. In one female the head and upper breast are almost solidly black. *Variants*.—There is no assuredly adult male in streaked plumage at hand. There is one male molting from streaked plumage into black, but this may be a molt from the juvenal plumage.

The available series consists of 24 specimens, all adult, 14 in the Academy collection (nos. 5942-5951, 6676-6679), 10 in the Stanford University collection. The birds of the Academy series, collected on September 14 and 15, have light colored bills throughout. Of the Stanford University series, Snodgrass & Heller (1904, p. 316) remark: “Our birds, which were taken in June, all have pinkish-horn-colored bills, but are apparently adult”. Rothschild & Hartert (1899, p. 162), after examining 65 specimens, say: “In no other species have we seen such a proportion of black-billed adult black males, while black males with yellowish beaks are very scarce. All the birds of the Harris’ expedition were killed in December.” The seasonal variation in bill color is thus apparent.

The Tower Island *acutirostris* is, to my notion, of the *Geospiza debiliostris* aggregation, but the differentiating characters are such as to make it seem desirable to treat the form as specifically distinct.

77. *Geospiza difficilis* Sharpe

Geospiza difficilis Sharpe, 1888, p. 12 (“Abingdon and Charles islands”; orig. descr.).—Rothschild & Hartert, 1899, p. 163; 1902, p. 397.—Ridgway, 1890, p. 107; 1897, p. 532; 1901, p. 507. *Geospiza fuliginosa difficilis* Snodgrass & Heller, 1904, p. 317. *Geospiza dentirostris* Sclater & Salvin, 1870, p. 323 (Abingdon).—Salvin, 1876, p. 483 (Abingdon).

GEOSPIZA DIFFICILIS Sharpe

Cotype.—British Museum, no. 85.12.14.321; ♂ ad.; Abingdon Island; December 14-30, 1868; Dr. A. Habel.

Cotype.—British Museum, no. 85.12.14.322; ♂ im.; Abingdon Island; December 15-30, 1868; Dr. A. Habel.

Cotype.—British Museum, no. 85.12.14.323; ♀; Abingdon Island; December 14-30, 1868; Dr. A. Habel.

Cotype.—British Museum, no. 75.4.2.14; ♂ im.; Abingdon Island; December 14-30, 1868; Dr. A. Habel.

No. 85.12.14.321 bears a red "type label."

In the original description seven specimens are listed, four from Abingdon. No type was indicated, but the one jet black male has been given a red "type label". Of the three from other islands, specimen "a" ("Galapagos Islands") is *Geospiza debilirostris*, specimens "f", "g", from Charles Island, are adult males, the first of *Geospiza fuliginosa*, the second of *Camarhynchus parvulus*.

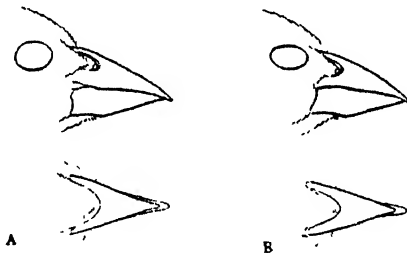


Fig. 34. a, *Geospiza difficilis*, male (no. 5216, coll. Stanford Univ.), Abingdon; b, *Geospiza acutirostris*, male (no. 5943), Tower. Natural size.

HABITAT.—The higher parts of Abingdon Island.

DESCRIPTION.—Most nearly like *G. acutirostris*, and of the same size, but with heavier, less acute bill. *Adult male*.—Uniform black except that the under tail coverts are margined with white or pale buff. *Adult female*.—Essentially like females of *acutirostris* in their dark coloration, except that neither of the two specimens at hand is black-headed, as are some of the *acutirostris* series. *Variants*.—A streaked male at hand closely resembles the females, but has brighter cinnamon bordering edges on the wing coverts.

A black male, nearly perfect otherwise, has the black feathers above and below narrowly edged with olivaceous, a common feature in other forms of *Geospiza*.

There are but two specimens in the Academy collection (nos. 6680, 6681), both collected September 21. These are adult females, both with black bills, and one labelled "ovaries large". The series at hand from the Stanford University collection consists of six males, four black and two streaked, all collected June 25. The bill is parti-colored in five; in one (a streaked bird) it is light colored. Five have nearly finished the annual molt. The bird with the light colored bill, presumably a bird of the year, is not obviously molting, but it is in freshly acquired plumage. According to Rothschild & Hartert (1899, p. 163), of a "large series" from Abingdon Island collected in August, there is none with a perfectly black bill.

This is a puzzling form from the systematic standpoint. It is so similar to *Geospiza fuliginosa* that Snodgrass & Heller treat it as a subspecies of that species, justifying their action, which places two subspecies of one species upon one small island, upon the grounds that *difficilis* and *minor* are found at different altitudes, *difficilis* at higher levels, *minor* at lower ones. Gifford (MS) also has written observations relating to the absence of *difficilis* at low elevations. For my own views as to the systematic position of *difficilis* see page 182.

78. *Geospiza debilirostris* Ridgway

Geospiza debilirostris Ridgway, 1894, p. 363 (James Island; orig. descr.); 1901, p. 508.—Rothschild & Hartert, 1899, p. 163.—Snodgrass & Heller, 1904, p. 333.

GEOSPIZA DEBILIROSTRIS Ridgway

Type.—United States National Museum, no. 116003; ♂ ad.; James Island; April 11 (1888); U. S. Fish Commission, Voyage of Albatross, 1887-88.

DESCRIPTION.—Of medium size (wing 66—72.5 mm.) and with somewhat elongated bill. *Adult male*.—Uniform black except that the under tail coverts are margined with white or buff. *Adult female*.—Almost or quite uniformly dusky above, streaked below. Generally dark colored, as in this whole group (*acutirostris*, *difficilis*, *debilirostris*, *septentrionalis*), as compared with the

lighter colored *magnirostris*, *fortis*, *fuliginosa* aggregation. Several females are nearly as dark as males, solidly blackish above and sparsely streaked below. *Juvenal*.—Essentially like the adult female in color and markings. Two males in streaked (not juvenal) plumage are indistinguishable from females.

HABITAT.—James and Indefatigable islands. Narborough Island?

Represented in the Academy collection by 77 specimens, 45 from James Island and 32 from Indefatigable (nos. 6868-6904, 6906-6918, 6920-6946). These were collected on James Island, January 2, 4; August 8; December 22, 28, 30. On Indefatigable, January 12, 18; July 12, 23, 24; November 8, 9, 10, 14.

The color of the bill in these birds is about as follows. James: In August specimens the bill is pale colored throughout. In December specimens it is mostly pale colored below, dusky above; a few are almost entirely light colored, a few almost entirely black. In January specimens it is mostly black; in a few it is dusky. In each series there is a greater proportion of pale colored bills among the females than among the males. Indefatigable: In July specimens the bill is pale colored throughout. In the November series there are some pale colored bills but in most cases it is more or less dusky. In most of the January birds the bill is black; in a few cases it is partly or entirely pale colored. The series includes only three females taken in November and three in January, and in all these the bill is pale colored.

Gifford (1919, p. 238) states that birds taken in December and January "showed no particular enlargement of the reproductive organs." Presumably the breeding season was a little later, as would be inferred from the parti-colored bills of December and January specimens, if I am correct in my belief that the bill becomes black in breeding birds.

Besides specimens actually collected on James and Indefatigable islands, there is a statement by Beck of some seen upon Narborough. On April 4 he saw birds there and took a set of eggs (Gifford, 1919, p. 238). It seems curious, if this observation is correct, that the species should not have been observed on Albemarle, where so much collecting has been done, and where, if on Narborough, the species should logically also occur.

Since the description of *Geospiza debilirostris* by Ridgway in 1894, it has been regarded as an isolated form. Rothschild & Hartert (1899, p. 163) make comparisons with *difficilis* and *fortis*,

Ridgway (1894, p. 363; 1896, p. 533; 1901, p. 508), with *fuliginosa* and *fortis*. Snodgrass & Heller (1904, p. 333) call attention to resemblances with *difficilis* and *septentrionalis*, but with no more than the resulting implication of close relationship.

It seems to me that there is a group of species and subspecies, closely related and closely similar, in the forms *nigrescens*, *septentrionalis*, *difficilis*, *acutirostris*, and *debilirostris*. These birds all have the same shaped bill (relatively long, slender and sharp-pointed), differing from one another in little more than in general size and in size of bill. They are much more closely like one another than like any other form of *Geospiza*. The similarity between *debilirostris*, *difficilis* and *septentrionalis* has been pointed

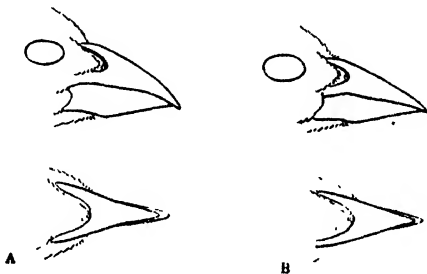


Fig. 35. *Geospiza debilirostris*, males: a (no. 6909), James; b (no. 6876), Indefatigable. Natural size.

out by Snodgrass & Heller (*loc. cit.*); that *acutirostris* belongs to the same aggregation seems evident.

There are six islands on which birds of this group occur, occupied, according to the treatment here adopted, by four species. These are *Geospiza septentrionalis*, divided into two subspecies, *nigrescens* and *septentrionalis*, on Culpepper and Wenman, respectively; *G. difficilis* on Abingdon; *G. acutirostris* on Tower; and *G. debilirostris* on James and Indefatigable. The differences between the extremes are considerable, but the medium sized *debilirostris* practically bridges the gap between the smaller *acutirostris* and *difficilis* and the larger *septentrionalis*. Selected specimens of *septentrionalis* and *debilirostris* are very closely alike.

All of the birds of this group might be regarded as subspecies of one species, but between the four species into which I here divide them there are sharper and wider differences than there are between the two forms of *septentrionalis* here recognized from Cul-

pepper and Wenman islands, respectively. On two other islands, James and Indefatigable, birds of the form found thereon (*debilirostris*) exhibit a perceptible average difference in size, larger on James, smaller on Indefatigable.

According to Gifford (1919, p. 237) *debilirostris* occurs in the green (humid) zone of Indefatigable and James, on the latter island at from 1500 feet altitude upward. It was not found in the low, arid sections of those islands. According to Snodgrass & Heller (1904, p. 317) *difficilis*, on Abingdon, is restricted to the higher (green, humid) zone, and absent below 500 feet altitude. Gifford (MS) has similar observations. This common habitat predilection of *debilirostris* and *difficilis* may be accepted as further evidence of the close relationship between the two that is suggested by structural features. In the case of *difficilis*, by accepting this relationship, we avoid the recognition of two subspecies upon one small island, the course followed by Snodgrass & Heller in treating *difficilis* as a subspecies of *fuliginosa*.

We may thus regard the *debilirostris* group as confined to the higher, humid zone upon Indefatigable, James, and Abingdon, where the lower, arid zone is occupied by members of the closely related *fuliginosa* group. Tower, Culpepper and Wenman islands are low lying and arid, with no parts occupied by the green, humid zone. They are, it is true, occupied by forms (*acutirostris* and *septentrionalis*) that I regard as of the *debilirostris* group, of the high zone on other islands, but it will be observed that Tower, Culpepper and Wenman have no representatives of the *fuliginosa* group. It is on islands where both these closely related groups occur that we find zonal differences in the distribution of the species. Bindloe, close to Abingdon (where *difficilis* occurs), is of too low altitude for the green, humid zone to be represented there; it has no representative of the *debilirostris* group, but it is occupied by a form of *fuliginosa*, namely, *G. f. minor*.

To put the facts a little differently: On the part of the Galapagos Archipelago where the *debilirostris* group occurs, those islands that are low and arid throughout are occupied entirely either by a representative of the *debilirostris* group or by a representative of the *fuliginosa* group, but not by both; those islands containing both low and arid, and high and humid zones, have representatives of each group, one in each zone.

79. *Geospiza septentrionalis septentrionalis* Rothschild & Hartert

Geospiza scandens septentrionalis Rothschild & Hartert, 1899, p. 165 (orig. descr.; Wenman Island); 1902, p. 399.—Hartert, 1919, p. 153 (particulars of type specimen, in Rothschild Museum).

Geospiza septentrionalis Ridgway, 1901, p. 510.—Snodgrass & Heller, 1904, p. 333.—Gifford, 1919, p. 241.

GEOSPIZA SCANDENS SEPTENTRIONALIS Rothschild & Hartert

Type.—Rothschild Museum; ♂ ad.; Wenman Island; August 4, 1897; Charles M. Harris (Webster-Harris expedition); orig. no. 311.

DESCRIPTION.—Of medium size (wing 68-74 mm.) and with elongated bill. *Adult male*.—Uniform black except that the under tail coverts are edged with buffy or cinnamon. No specimens at hand show whitish feather edgings. *Adult female*.—A dusky, streaked bird, with the dark markings inclined to fuse anteriorly so as to produce a black-headed effect. Ground color below buffy; edgings to wing coverts dark cinnamomeous. *Juvenal*.—Essentially similar to adult female. Young of both sexes are distinctly black-headed, an effect that is emphasized by the fact that the ventral streaks are narrow and obscurely defined.

HABITAT.—Wenman Island.

Represented in the Academy collection by 57 specimens (nos. 6947-6980, 6991, 6994-7015). all collected on September 24, 1906. I have also at hand 13 additional skins from the Stanford University collection taken during December, 1898.

Rothschild & Hartert (1899, p. 165; 1902, p. 399) regard *septentrionalis* as a subspecies of the *Geospiza scandens* aggregation, but I agree with Snodgrass & Heller (1904, p. 333) in considering it as specifically distinct. I believe that its closest relationships lie with the *debilirostris-difficilis-acutirostris* aggregation, here called the *debilirostris* group. As regards characters distinguishing the two forms of *septentrionalis*, it will be noted that besides differences in size and shape of bill, there is a difference in the proportionate number of black males upon the two islands. On Culpepper, out of 18 males, 12 are black and of the remaining six, five, though not entirely black, are mostly so: only one is streaked. Of 38 males from Wenman, there are only three that are black; the majority are indistinguishable from females. However, in the Rothschild Museum series, out of 18 males from Wenman, 15 are black,

3 streaked. These different proportions in series collected in different years are extremely puzzling. There are four birds in juvenal plumage at hand from Wenman Island, two males and two females. They are all black-headed to a marked degree, distinctly more so than any adult female in the series, and more so than most of the streaked males.

In most of the males of our September series the bill is light colored, in a few it is dusky or black. Most of the blackish-billed birds are marked "testes large"; presumably the breeding season was drawing near. No bird with light colored bill has the label so annotated. The females and young have all light colored bills.

30. *Geospiza septentrionalis nigrescens* new subspecies

Geospiza scandens septentrionalis Rothschild & Hartert, 1899, p. 165, part (Culpepper Island).

Geospiza septentrionalis Ridgway, 1901, p. 510, part (Culpepper Island).—Snodgrass & Heller, 1904, p. 333, part (Culpepper Island).

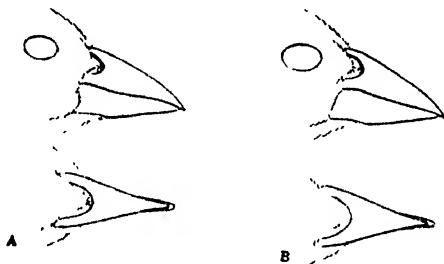


Fig. 36. *Geospiza septentrionalis*, males: a, *G. s. septentrionalis* (no. 6955), Wenman; b, *G. s. nigrescens* (no. 6984), Culpepper. Natural size.

Type.—Male adult, no. 6984, Mus. Calif. Acad. Sci.; Culpepper Island, Galapagos Archipelago; September 25, 1906; collected by R. H. Beck.

CHARACTERS.—Similar to *Geospiza septentrionalis septentrionalis*, but with larger (both longer and heavier) bill.

HABITAT.—Culpepper Island.

Represented in the Academy collection by 14 specimens (nos. 6981-6990, 6992, 6993, 7016, 7017), all collected on September

25, 1906. There are also at hand 7 skins from the Stanford University collection, taken on December 10, 1898. None of our September taken series has the bill black. In two adult males the upper mandible is partly dusky; in all the others the bill is entirely light colored. In the December series the bill is in some cases light colored, in others parti-colored and mostly dusky.

This is a slightly differentiated form, but one that it seems to me is worthy of nomenclatural recognition. This and typical *septentrionalis* differ in about the same way and to the same degree as do the several recognized subspecies of *Geospiza scandens*.

SPECIMENS OF THE *Geospiza debilirostris* GROUP IN THE ACADEMY COLLECTION AND
(FIGURES IN PARENTHESES) IN THE STANFORD UNIVERSITY COLLECTION

Name	Island	Male (black)	Male (streaked)	Female	Young	Sex unde- termined
<i>Geospiza s. nigrescens</i>	Culpepper	6 (6)	5 (1)	2 (1)		1
<i>Geospiza s. septentrionalis</i>	Wenman	3 (5)	29 (1)	21 (6)	4	
<i>Geospiza difficilis</i>	Abingdon	(4)	(2)	2		
<i>Geospiza acutirostris</i>	Tower	10 (7)	(1)	4 (2)		
<i>Geospiza debilirostris</i>	James	29		16 (2)		
<i>Geospiza debilirostris</i>	Indefatigable	19	4	9		

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM) OF SPECIES AND
SUBSPECIES OF THE *Geospiza debilis* GROUP

MALES

Number of specimens	Name	Island	Wing	Tail	Culmen	Gonys	Depth of bill at base	Width of mandible at base	Tarsus	Middle toe with claw
10	<i>Geospiza s. nigrescens</i>	Culpepper	71.9 (70.0-73.0)	47.9 (46.0-50.0)	13.5 (14.5-17.0)	8.9 (8.0-9.5)	8.9 (8.2- 9.2)	7.4 (6.8-8.0)	22.9 (22.0-23.5)	19.8 (18.0-20.6)
10	<i>Geospiza s. septentrionalis</i>	Wenman	71.1 (68.0-74.0)	45.3 (43.5-48.0)	14.1 (13.2-15.0)	8.5 (8.0-9.5)	8.0 (7.5- 8.3)	6.9 (6.5-7.2)	22.1 (21.2-23.0)	19.0 (18.0-20.5)
6	<i>Geospiza difficilis</i>	Abingdon	61.1 (60.5-62.2)	37.5 (35.0-39.2)	14.3 (13.8-14.5)	7.7 (7.5-7.9)	8.2 (8.0- 8.5)	6.6 (6.0-7.0)	20.9 (20.5-21.2)	19.0 (18.5-19.5)
10	<i>Geospiza acutirostris</i>	Tower	62.3 (61.0-65.0)	38.3 (36.0-41.2)	12.4 (11.5-13.5)	7.2 (7.0-7.3)	7.8 (7.2- 8.0)	6.4 (6.0-6.8)	19.0 (18.5-20.0)	16.1 (15.0-17.0)
10	<i>Geospiza debilis</i>	James	70.3 (68.2-72.5)	41.2 (39.5-45.0)	14.3 (14.0-15.8)	7.9 (7.2-8.5)	9.4 (8.5-10.2)	7.7 (7.2-8.0)	23.9 (23.0-26.0)	20.7 (19.0-22.2)
10	<i>Geospiza debilis</i>	Indefatigable	67.5 (66.0-69.0)	41.3 (39.0-44.5)	14.3 (12.8-15.0)	7.4 (7.0-8.0)	8.5 (8.0- 9.2)	7.2 (7.0-7.5)	22.1 (20.5-23.5)	19.3 (18.0-20.6)

FEMALES

Number of specimens	Name	Island	Wing	Tail	Culmen	Gonys	Depth of bill at base	Width of mandible at base	Tarsus	Middle toe with claw
3	<i>Geospiza s. nigrescens</i>	Culpepper	68.5 (66.0-69.0)	46.5 (46.0-47.0)	14.8 (14.5-15.0)	8.9 (8.9-9.0)	8.3 (8.0- 8.5)	7.1 (7.0-7.2)	21.9 (21.5-22.2)	19.7 (19.5-19.8)
10	<i>Geospiza s. septentrionalis</i>	Wenman	67.2 (66.0-68.0)	45.3 (43.0-46.5)	14.3 (13.5-15.0)	8.4 (8.0-9.0)	7.7 (7.2- 8.2)	6.6 (6.2-7.0)	20.9 (20.5-21.5)	18.3 (17.2-19.0)
2	<i>Geospiza difficilis</i>	Abingdon	59.0-59.8	35.0-35.0	14.0-14.0	8.0-8.0	8.2- 8.5	6.5-6.8	20.5-21.0	18.0-18.5
6	<i>Geospiza acutirostris</i>	Tower	60.0 (58.5-60.8)	37.1 (35.0-39.5)	12.2 (11.8-12.6)	7.3 (6.8-7.3)	7.4 (7.0- 8.0)	6.0 (5.8-6.2)	18.5 (17.5-19.2)	15.2 (14.8-15.8)
10	<i>Geospiza debilis</i>	James	67.8 (66.5-70.0)	38.3 (36.0-41.0)	14.6 (13.8-15.0)	7.7 (7.2-8.5)	9.2 (8.5- 9.8)	7.0 (6.5- 8.0)	23.1 (21.5-24.2)	20.2 (19.2-21.6)
9	<i>Geospiza debilis</i>	Indefatigable	66.1 (64.0-68.5)	40.3 (38.5-42.2)	13.6 (13.0-14.5)	7.2 (7.0-8.0)	8.5 (8.0- 9.0)	7.0 (6.5-7.5)	22.1 (21.2-23.0)	19.8 (19.0-21.0)

Geospiza scandens (Gould)

Birds of this aggregation occur upon all of the central islands. They have not been found on certain of the outlying islands, on Culpepper and Wenman at the extreme north, on Tower at the northeast, or on Hood at the southeast. They are not known to occur upon Narborough but it is likely that they do so.

Rothschild & Hartert (1899) place under the specific name *Geospiza scandens* five subspecies: *scandens* (James Id.), *intermedia* (Charles Id.), *fatigata* (Indefatigable, Duncan, Albemarle, Jervis, Chatham, and Barrington islands), *abingdoni* (Abingdon and Bindloe islands), *septentrionalis* (Culpepper and Wenman islands). Snodgrass & Heller (1904), in the subgenus *Cactornis*, under the "*Geospiza scandens* series" place four subspecies, differing in some details from the arrangement by Rothschild & Hartert: *scandens* (James and Charles islands), *fatigata* (Indefatigable, Seymour, Barrington, Chatham, Duncan, Jervis, and Albemarle islands), *abingdoni* (Abingdon Id.), *rothschildi* (Bindloe Id.). *Septentrionalis* (Wenman and Culpepper islands) they regard as a distinct species and in another subgenus, *Geospiza*. Ridgway (1901), consistently denying subspecific treatment to all Galapagos forms, recognizes the following six species in the order here given: *scandens* (James Id.), *septentrionalis* (Wenman and Culpepper islands), *intermedia* (Charles and Gardner-near-Charles islands), *fatigata* (Indefatigable, Duncan, Albemarle, Jervis, Chatham, and Barrington islands), *abingdoni* (Abingdon Island), *rothschildi* (Bindloe Id.). *Barringtoni* (Barrington Id.) is doubtfully synonymized under *fatigata*. The differences obtaining among these several systems and my own are not radical: they mostly involve matters of detail and of expression of ideas.

In what has been called the *Geospiza scandens* series (from which, in agreement with Snodgrass & Heller, I would exclude *septentrionalis*) it must be emphasized that there is such slight variation upon the several islands involved that it is indeed a question as to whether *scandens*, *intermedia*, *abingdoni*, and *rothschildi* might not well be placed all under one name. In any event, considering the triviality of the differences and the wide overlapping of characters between the several forms, it certainly seems best to treat these four as subspecifically related, whereby proper emphasis is also laid upon the relatively wide gap between the *scandens* series and any other form of *Geospiza*.

Variation consists almost entirely in size and shape of bill. *Geospiza s. scandens*, upon James Island, has notably the smallest bill of the several forms; the bill is both short and slender. Jarvis Island birds show a slight increase in size, but are still best in-

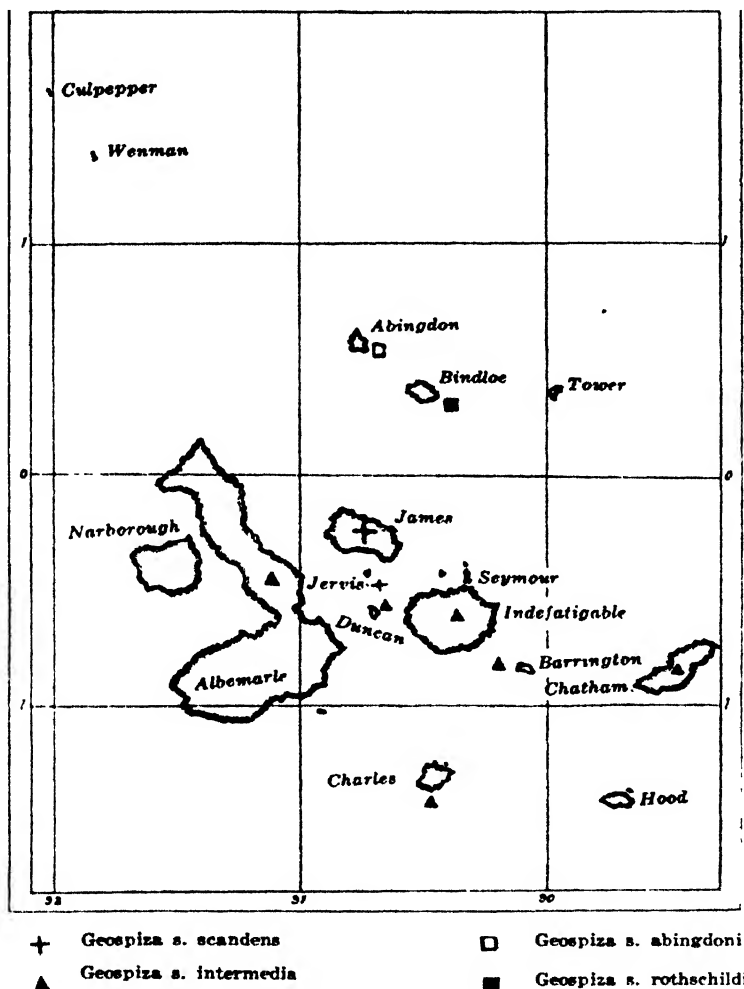


Fig. 37. Map showing distribution of the subspecies of *Geospiza scandens*. Symbols indicate islands where recorded.

cluded under the same name. Slightly longer and heavier of bill is the form *intermedia*, under which name may be included the birds upon Albemarle, Duncan, Indefatigable, Charles, Barrington, and

Chatham. It is possible that additional specimens from Chatham will demonstrate the existence of a distinguishably stubby-billed form upon that island, as is suggested by the few skins at hand.

It will be seen that from a minimum of bill size upon the centrally located James Island, there is increase in this measurement upon all islands to the southward. There is also such increase to the northward, in Abingdon Island birds (*abingdoni*), and still more so in the Bindloe Island form (*rothschildi*). So that variation in this species can not be traced in a linear direction, island by island, but from a central point (James Island) in various directions. There is no difference that I can see between the bill of *abingdoni*, north of James Island, and that of *intermedia* of Indefatigable Island to the southward. Differences here are of color, *abingdoni* being almost or entirely destitute of the black phase in the adult male, and showing minor differences in streaking and ground color, as compared with *intermedia*. *Rothschildi* takes a new course in increased heaviness of bill through thickening of the lower mandible.

Geospiza scandens (including four subspecies, *scandens*, *intermedia*, *abingdoni*, and *rothschildi*) is represented in the Academy collection by 391 specimens*, as indicated in the accompanying table.

81. *Geospiza scandens scandens* (Gould)

Cactornis scandens Gould, 1837a, p. 7 (Galapagos Islands; orig. descr.); 1841, p. 104, pl. 42 (James Island).—Sundevall, 1871, p. 124.—Salvin, 1876, p. 485.—Sharpe, 1888, p. 19.

Geospiza scandens Ridgway, 1896, p. 534; 1901, p. 509.

Geospiza scandens scandens Rothschild & Hartert, 1899, p. 164.—Snodgrass & Heller, 1904, p. 336.

CACTORNIS SCANDENS Gould

Type.—British Museum, no. 55.12.19.25; (♂ ad.: Galapagos Islands): "ex coll. Darwin".†

Sharpe (1888, p. 20) lists two skins as "types of species." The above is apparently Sharpe's specimen *a*, and it bears a red "type label." Sharpe's specimen *b* (Brit. Mus. no. 55.12.19.20; ♀?) is an example of *Geospiza debilirostris*.

*Entered in the Academy catalogue (not segregated by subspecies) under the numbers 6029, 7018-7407.

†James Island; collected by C. Darwin; ex Zoological Society's collection. N.B.K.

DESCRIPTION.—Of medium size (wing about 70 mm.); bill elongate and sharp-pointed. *Adult male.*—Uniform black except that the under tail coverts are more or less broadly margined with white or pale buff. *Adult female.*—A dusky appearing bird, almost uniformly blackish above. Breast and flanks heavily streaked with blackish, the streaks on chin and throat in many specimens running together to form a "solid" dark area of varying size. Middle of belly immaculate, whitish; under tail coverts streaked with dusky. In the females at hand (none in very fresh plumage) the wing coverts are faintly edged with pale brownish or grayish. There is no trace of cinnamomeous in these edgings, but the absence of this color may be due to fading. *Juvenal.*—Essentially like the adult female, but with dusky feathers of upper parts edged with olivaceous, and with wing coverts edged with cinnamomeous, both of which features, however, may be present to some extent in adult females in fresh, unfaded plumage.

HABITAT.—James and Jervis islands.

Represented by the following specimens. James Island: 3 males (black), 1 adult female; Jervis Island: 5 males (black), 3 adult females. Of the James Island birds, one black male (July 30) has the bill dusky; two males (December 19) black, with some streaks on the belly, and in extremely worn plumage (evidently on the verge of molt), have the bill light colored: the one female (December 19) has the bill dusky above, light colored below. It should be observed that the two males with light colored bills, though collected in the breeding season, were not breeding birds, as is noted in Gifford's (1919, p. 241) field observations.

Of the five black males from Jervis Island (two collected on December 18, three on December 21), four have the bill black or mostly black, in one it is dusky above, light colored below. Two adult females (December 20) have the bill dusky above, light colored below. According to Gifford's (*loc. cit.*) field notes, the two black-billed males collected on December 18 were in breeding condition. On the other specimens there are no pertinent observations.

In the combined series of the collections of the Academy and of Stanford University, there are 10 adult males from James Island and 5 from Jervis Island, all of which are in black plumage. Two from James Island (as noted above) have some streaks on the belly, but they are essentially black and not streaked as regards

their general plumage. In Gifford's field notes above cited (p. 241) he remarks: "During our sojourn on Jervis on December 18 most of the birds seen were black males." Evidently black plumage in the adult male is the common condition on James and Jervis islands.

Five young birds in the Stanford University collection (April 21, 22) are in juvenal plumage throughout. In color and markings these are essentially like the adult female, being streaked below to about the same degree. The bill is mostly dusky above, light colored below.

There is one specimen at hand from Jervis Island (Calif. Acad. Sci. no. 7376, adult female, December 21, 1905) that I keep under *Geospiza s. scandens* from sheer inability to place it elsewhere, but in bill measurements it lies outside the normal range of varia-

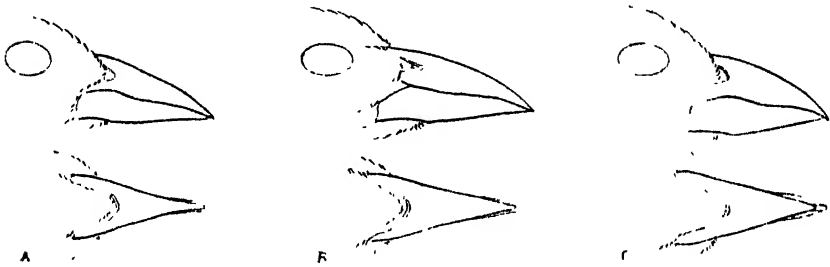


Fig. 38. *Geospiza scandens*, males: a, *G. s. scandens* (no. 7018), James; b, *G. s. intermedia* (no. 7165), Indefatigable; c, aberrant individual, tentatively referred to *G. s. scandens* (no. 7376), Jervis. Natural size.

tion of this subspecies (see fig. 38, c). It measures as follows: wing 67.2; tail 39.8; culmen 18.0; gonys 10.5; depth of bill at base 11.2; width of mandible at base 9.0; tarsus 22.5; middle toe with claw 19.2. The bill of this bird is heavier than in any of the subspecies of *Geospiza scandens*, though the difference in shape is such as not to be accurately reflected in the measurements here given. It is, in fact, intermediate in size and shape between *Geospiza scandens* and *G. propinqua* of Tower Island. This specimen was collected by E. W. Gifford (field no. 1756), and Gifford's field note book, under date of December 21, 1905, contains the following entry pertaining to it: "I obtained one *Geospiza* which seemed to be a sort of a cross between a *Geospiza scandens* and a *Geospiza strenua*".

82. *Geospiza scandens intermedia* Ridgway

Geospiza intermedia Ridgway, 1894, p. 361, in text (Charles Island; orig. descr.); 1897, p. 535; 1901, p. 511.

Geospiza scandens intermedia Rothschild & Hartert, 1899, p. 164.

Geospiza barringtoni Ridgway, 1894, p. 361 (Barrington Island; orig. descr.).

Geospiza fatigata Ridgway, 1896, p. 293 (Indefatigable Island; orig. descr.); 1897, p. 539; 1901, p. 511.

Geospiza scandens fatigata Rothschild & Hartert, 1899, p. 164.—Snodgrass & Heller, 1904, p. 338.

Cactornis scandens Sclater & Salvin, 1870, p. 323.—Salvin, 1876, p. 485.

GEOSPIZA INTERMEDIA Ridgway

Type.—United States National Museum, no. 115916; ♂ ad.; Charles Island; April 8 (1888); U. S. Fish Commission, Voyage of the Albatross.

GEOSPIZA BARRINGTONI Ridgway

Type.—Rothschild Museum; ♂ ad.; Barrington Island; July, 1891; Dr. G. Baur; orig. no. 596. "Ex spirits."

GEOSPIZA FATIGATA Ridgway

Type.—United States National Museum, no. 116048; ♂ ad.; Indefatigable Island; April 12 (1888); U. S. Fish Commission, Voyage of the Albatross.

DESCRIPTION.—Essentially similar to *G. scandens scandens*, from which it differs in slightly heavier bill. *Juvenal*.—There is rather remarkable color variation among some of the young birds. Among juveniles from Charles Island there are some that are almost uniformly black, others very pale colored, sparsely streaked on the breast and otherwise almost immaculately dirty whitish below. These variants are of the same sex and at exactly the same stage of existence, each in the plumage immediately following the natal down.

HABITAT.—Albemarle, Duncan, Indefatigable, Charles, Barrington, and Chatham islands and adjacent islets.

Represented by 351 specimens. These were collected on the several islands during the following months: Duncan, August, December; Indefatigable, January, July, October, November; Seymour, July, November; Daphne, July, November; Albemarle, March, April, August, November; Charles, February, March, May, June,

October; Gardner-near-Charles, October; Champion, October; Barrington, July, October; Chatham, February, July.

It will be noted that different islands vary in the proportion of black-plumaged males. It must be pointed out in this connection that the divisions I have made between black and streaked males are arbitrary to this extent, that as every intermediate degree may be found in some series, I have in some cases made divisions between those mostly black, on the one hand, and those mostly streaked, on the other. In the Barrington Island series, for example, there are 18 pure black males; in the 14 remaining male birds the black on the lower surface is more or less interrupted by light-colored margins to the feathers. Every one of these birds, though, is distinguishable from the streaked female, so I have here listed them as all in the same phase. Variation in bill color, black, dusky, parti-colored, or pale colored, can for the most part be correlated with the seasons, December and January birds being mostly black-billed, July and August birds mostly yellowish-billed.

There are birds in juvenal plumage from Indefatigable, collected January 12 and 18, one from Albemarle, March 15, and a number from Charles during May. Young males average darker than young females, and there is nearly as great variation among them as among adult males. Some males in juvenal plumage are distinctly blackish, far darker and more uniformly blackish than streaked males in later plumage stages.

There is a young bird in the collection (as recorded by Gifford, 1919, p. 241) that was collected at sea 20 miles south of Indefatigable, May 18, 1906. That distance from Indefatigable would be a much lesser distance from Charles, and the vessel at the time was travelling from Charles to Chatham. As far as specific characters go, or place of capture either, it might have come from either Charles, Indefatigable, or Barrington, but in any event it is of decided interest that a bird of this species, especially as being in juvenal plumage, should have been found so far from land.

There is such close similarity between birds of this species upon all of the southern islands that I feel no hesitation in lumping them under the one subspecific name, *intermedia*. The only exception to this statement may lie in the bird of Chatham Island. This island is inadequately represented, the entire series consisting of eight specimens, but these birds and four more in the Rothschild collection have clearly a relatively short heavy bill, as compared with others. There are no black males in the

series, but in the four February taken adults (the two males marked "testes large") the bill is black, indicative, as I believe, of the bird being in breeding condition. If there really proves to be a stubby-billed variant upon Chatham it will afford an interesting parallel to conditions in the *Cactospiza pallida* aggregation where Chatham Island is occupied by a heavy-billed form of this generally long-billed species.

There are at hand in the combined series of the Stanford University and the Academy collections 65 skins from Barrington Island, quite sufficient for a basis of judgment upon *Geospiza barringtoni* Ridgway (1894, p. 361). I can see no tangible features for distinguishing this form. In extensive series from any one island there are a few surprising variants in size and shape of the bill, and the name *barringtoni* was based upon an unusual bird of this sort.

83. *Geospiza scandens abingdoni* (Sclater & Salvin)

Cactornis abingdoni Sclater & Salvin, 1870, pp. 323, 326, fig. 5 (Abingdon Island; orig. descr.).—Salvin, 1876, p. 486, fig.—Sharpe, 1888, p. 20.—Ridgway, 1890, p. 108.

Geospiza abingdoni Ridgway, 1897, p. 540; 1901, p. 513.—Gifford, 1919, p. 239, part.

Geospiza scandens abingdoni Rothschild & Hartert, 1899, p. 165; 1902, p. 398.—Snodgrass & Heller, 1904, p. 340.

CACTORNIS ABINGDONI Sclater & Salvin

Cotype.—British Museum, no. 85.12.14.561; ♂ ad.; Abingdon Island; December 14-30, 1868; Dr. A. Habel.

Cotype.—British Museum, no. 75.4.2.62; ♂ ad.; Abingdon Island; December 14, 1868; Dr. A. Habel.

No. 85.12.14.561 now bears a red "type label".

DESCRIPTION.—Essentially similar to *G. scandens scandens*, from which it differs in slightly heavier bill. Differs from *scandens*, *intermedia*, and *rothschildi* in that the adult male rarely assumes the entirely black plumage. *Adult male*.—Usually dull black, "solidly" so on head, neck, upper breast and back. Black feathers of lower breast and sides narrowly edged with whitish, producing a streaked effect. A restricted mid-ventral area unmarked. Under tail coverts narrowly streaked with dusky centrally. Wing coverts narrowly edged with rusty. *Adult female*.—Indistinguishable from the male just described. *Juvenal*.—Birds in juvenal plumage are

in general appearance just like the adults, being dark colored and notably black-headed. Coloration is almost uniform, there being scarcely a trace of ventral streaking. *Variant*.—One adult female in the series is appreciably paler colored than the others, with a much more extensive unmarked area below.

HABITAT.—Abingdon Island.

Represented by the following specimens: adult male, 5, adult female, 8, juvenal female, 1. They were collected on the three days, September 20-22. In one male and four females the bill is mostly dusky, in the others it is dusky above and light colored below, in varying degrees.

The black phase of plumage seems to be very rare in this form. *Cactornis abingdoni* (Sclater & Salvin, 1870, p. 326) was described



Fig. 39. *Geospiza scandens*: a, *G. s. abingdoni* (no. 7225, male), Abingdon; b, *G. s. rothschildi* (no. 5122, female, coll. Stanford Univ., type), Bindloe. Natural size.

from two specimens, neither of which was black: the five adult males in the Academy series are all streaked; Snodgrass & Heller (1904, p. 340) secured only "immature" specimens upon Abingdon; and Rothschild & Hartert (1899, p. 165) had "no perfectly adult males". In a later publication Rothschild & Hartert (1902, p. 398) speak of "one fully adult male" (which I have seen), the only evidence known to me of the occurrence of this phase upon Abingdon. In apparently mature male birds the head and upper breast are dull black, the rest of the lower parts more or less streaked. The streaked feathers are dusky at the center, and margined more or less broadly with buffy or dark grayish, the marginal area increasing toward the posterior end of the body.

The sexes are essentially alike, some females having as much black on head and breast as any of the males, though on the average females are more extensively streaked.

The inclusion in the Academy series of a bird in juvenal plumage collected on September 22 seems rather extraordinary. From published data at hand (see Gifford, 1919, p. 239) and from other evidence it would appear that the breeding season ordinarily begins in December.

Associated with the scarcity of the entirely black phase is the apparently contradictory character of generally darker coloration in the streaked phase in *abingdoni*, as compared with *scandens* and *intermedia*. The dully black-headed coloration that is the usual thing in *abingdoni* is of rare occurrence in *scandens* and *intermedia*, where the ventral streaking usually extends forward over breast and throat. In *abingdoni* the ground color forming the background to the streaking upon the body is buffy, whereas in *scandens* and *intermedia* it is more grayish.

84. *Geospiza scandens rothschildi* Heller & Snodgrass

Geospiza scandens rothschildi Heller & Snodgrass, 1901, p. 75 (Bindloe Island; orig. descr.).—Snodgrass & Heller, 1904, p. 341.

Geospiza rothschildi Ridgway, 1901, p. 673.

Geospiza scandens abingdoni Rothschild & Hartert, 1899, p. 165, part; 1902, p. 398, part.

GEOSPIZA SCANDENS ROTHSCILDI Heller & Snodgrass

Type.—Leland Stanford Junior University, no. 5122; ♀ im.: Bindloe Island: June 21, 1899; R. E. Snodgrass and E. Heller (Hopkins-Stanford Galapagos expedition); orig. no. 152.

DESCRIPTION.—Differs from *scandens*, *intermedia*, and *abingdoni*, in its slightly heavier bill, with especially heavier lower mandible. *Adult male*.—Uniform black except that the under tail coverts are more or less broadly margined with whitish or pale buffy. *Adult female* and male in streaked plumage exactly like corresponding stages in *G. s. abingdoni*.

HABITAT.—Bindloe Island.

Represented by nine specimens, four adult (entirely black) males, and five adult females, collected on September 17. There are also at hand the series of seven specimens (including the type) upon which Heller & Snodgrass based the form *rothschildi*. Of the Academy series, three of the black-plumaged males have the bill mostly black with a small light colored spot on the lower

mandible, the fourth black male has the lower mandible mostly light colored, and the five females have the upper mandible mostly dusky, the lower mostly light colored. Of the Stanford University series (collected June 20, 21, 1899) the bills are all mostly light colored, with some dusky on the upper mandible. The Stanford University series were described as immature birds, and so presumably they are. They are not in the juvenal plumage but are severally either undergoing or have just undergone the post-juvenal molt.

The differences between *rothschildi* and *abingdoni* are slight, but *rothschildi* certainly has a slightly heavier bill than *abingdoni*, as claimed by Snodgrass & Heller, a difference that is more apparent upon comparison of specimens than by comparison of measurements. It is an interesting feature of this difference that the increased thickness in *rothschildi* lies entirely in the lower mandible, and this gives a distinctive character to the shape of the entire bill that is out of proportion to the small increase in size. The apparently common occurrence of black males upon Bindloe Island is a feature that should be given some weight in any comparison with *abingdoni*, in which that plumage phase is exceedingly rare.

CACTORNIS ASSIMILIS Gould

Cotype.—British Museum. no. 55.12.19.15;(??): Galapagos Islands; received from Zoological Society of London.

Cotype.—British Museum, no. 37.2.21.415;(??): Galapagos Islands; received from Burnett and Fitzroy.*

The proper application of the name *Cactornis assimilis* Gould (1837, p. 7) is apparently indeterminable. The type is in the British Museum and there is a second specimen, received from Burnett and Fitzroy, that is practically a duplicate, neither with exact data. These birds are of the *scandens* group; they have heavy bills and look very like females of *rothschildi* of Bindloe Island. As, however, the "Beagle" collections are not known to have included any specimens from Bindloe, though it was apparently visited by a party detached from the ship, I do not care to substitute the name *assimilis* for *rothschildi*. Neither can the specimens be matched in series from any other island. Hence, although *assimilis* is not a synonym of *scandens* and has priority over all other names in the *scandens* group, it is not possible to use it for any of the forms since described.

*Both birds in female plumage but sex not indicated on labels. From some other source Mr. Kinnear gives data of no. 37.2.21.415 as: "male; James Island."

SPECIMENS OF THE *Geospiza scandens* GROUP IN THE ACADEMY COLLECTION AND
(FIGURES IN PARENTHESES) IN THE STANFORD UNIVERSITY COLLECTION

Name	Island	Male (black)	Male (streaked)	Female	Young	Sex unde- termined
<i>Geospiza scandens abingdoni</i>	Abingdon					
<i>Geospiza scandens rothschildi</i>	Bindloe	4	5 (4)	8 (3)	1 (1)	
<i>Geospiza scandens scandens</i>	James	3 (7)	(3)	5 (4)		
<i>Geospiza scandens scandens</i>	Jervis	5		1	(5)	
<i>Geospiza scandens intermedia</i>	Duncan	1	4	8		
<i>Geospiza scandens intermedia</i>	Indefatigable	25	7 (2)	18 (1)	3	2 (1)
<i>Geospiza scandens intermedia</i>	Seymour	4 (8)	12 (4)	13 (1)		
<i>Geospiza scandens intermedia</i>	Daphne	1		1		
<i>Geospiza scandens intermedia</i>	Albemarle	7 (1)	9	5	1	1 (2)
<i>Geospiza scandens intermedia</i>	Barrington	32 (13)		14 (4)		1
<i>Geospiza scandens intermedia</i>	Chatham		2 (1)	3 (1)		1
<i>Geospiza scandens intermedia</i>	Charles	43 (3)	29	48 (1)	36	15 (1)
<i>Geospiza scandens intermedia</i>	Gardner-near-Charles		2			
<i>Geospiza scandens intermedia</i>	Champion	1		1		

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM) OF THE
SUBSPECIES OF *Geospiza scandens*

MALES

Number of specimens	Name	Island	Wing	Tail	Culmen	Gonys	Depth of bill at base	Width of mandible at base	Tarsus	Middle toe with claw
6	<i>Geospiza s. abingdoni</i>	Abingdon	70.9 (69.0-73.0)	45.8 (43.0-48.0)	18.7 (18.0-19.8)	10.9 (10.5-11.2)	9.6 (9.0-10.0)	8.1 (7.2-8.5)	21.9 (21.0-22.5)	19.7 (18.5-20.9)
8	<i>Geospiza s. rothschildi</i>	Bindloe	70.7 (67.5-75.0)	43.1 (41.0-44.0)	19.3 (18.0-21.0)	11.5 (11.0-12.0)	10.3 (9.5-11.5)	8.3 (7.5-9.5)	21.8 (21.0-23.5)	19.3 (18.0-21.0)
10	<i>Geospiza s. scandens</i>	James	69.1 (67.5-71.0)	41.9 (40.0-43.5)	17.0 (16.0-17.8)	10.3 (10.0-10.5)	8.6 (8.0-9.0)	7.3 (7.0-8.0)	21.2 (20.2-22.5)	18.9 (18.0-20.0)
6	<i>Geospiza s. scandens</i>	Jervis	71.4 (70.5-72.5)	43.7 (42.0-45.0)	18.0 (18.5-19.5)	10.9 (10.0-11.5)	8.8 (8.5-9.0)	7.3 (6.2-8.0)	21.2 (21.0-22.0)	19.1 (18.5-20.0)
10	<i>Geospiza s. intermedia</i>	Albemarle	71.5 (68.5-74.0)	42.6 (40.0-44.0)	18.5 (17.5-19.8)	11.2 (10.5-12.0)	9.3 (9.0-10.0)	7.9 (7.5-8.5)	22.3 (21.2-23.2)	19.9 (18.5-20.2)
5	<i>Geospiza s. intermedia</i>	Duncan	69.8 (68.0-70.2)	41.9 (40.5-43.0)	18.8 (18.2-19.5)	10.9 (10.5-12.0)	9.5 (9.0-10.0)	7.7 (7.2-8.0)	22.1 (21.2-23.0)	20.0 (19.2-21.0)
10	<i>Geospiza s. intermedia</i>	Indefatigable	71.2 (70.0-73.0)	42.8 (41.5-44.0)	20.1 (19.5-21.0)	11.8 (10.5-12.5)	9.6 (9.0-10.0)	8.0 (7.5-8.2)	22.3 (21.5-23.0)	19.8 (19.0-21.0)
3	<i>Geospiza s. intermedia</i>	Chatham	68.9 (67.0-71.5)	41.8 (40.2-43.2)	17.2 (17.0-17.5)	10.0	9.3 (9.0-9.5)	7.6 (6.5-8.2)	21.4 (21.2-21.5)	20.4 (20.0-20.8)
10	<i>Geospiza s. intermedia</i>	Harrington	69.8 (67.0-73.0)	43.5 (39.0-46.5)	18.2 (17.0-20.0)	10.9 (10.5-11.2)	9.7 (9.0-10.2)	8.1 (7.5-8.5)	22.5 (22.0-23.2)	20.3 (19.2-22.0)
10	<i>Geospiza s. intermedia</i>	Charles	70.1 (66.5-72.0)	43.5 (41.5-45.0)	17.8 (17.0-18.5)	10.9 (10.0-11.5)	9.1 (8.5-9.5)	7.6 (7.5-8.0)	22.1 (21.0-23.0)	20.2 (18.5-21.0)

FEMALES

10	<i>Geospiza s. abingdoni</i>	Abingdon	68.1 (65.2-72.0)	41.9 (38.5-44.0)	18.9 (17.2-20.2)	11.1 (10.5-12.0)	9.3 (8.5-10.5)	7.4 (6.8-8.2)	21.5 (21.0-22.5)	19.3 (18.0-20.5)
8	<i>Geospiza s. rothschildi</i>	Bindloe	68.8 (66.0-72.5)	41.1 (37.5-43.5)	19.5 (18.5-20.2)	11.4 (10.5-12.2)	10.0 (9.5-11.0)	8.4 (7.8-9.2)	21.8 (20.8-23.0)	19.5 (18.5-20.5)
1	<i>Geospiza s. scandens</i>	James	68.2	42.0	18.0	10.5	8.2	7.2	20.5	19.0
5	<i>Geospiza s. scandens</i>	Jervis	68.3 (64.0-68.0)	38.1 (35.0-40.0)	18.2 (18.5-20.0)	10.6 (9.5-11.5)	8.9 (8.0-9.5)	7.2 (6.8-7.5)	20.8 (20.5-21.5)	18.7 (18.0-19.0)
5	<i>Geospiza s. intermedia</i>	Albemarle	68.5 (65.0-72.5)	41.5 (39.0-43.5)	18.9 (17.5-20.0)	11.0 (10.2-11.5)	8.9 (8.5-9.5)	7.1 (6.5-7.8)	21.7 (21.0-22.0)	19.5 (18.5-20.0)
8	<i>Geospiza s. intermedia</i>	Duncan	68.1 (65.0-70.0)	40.1 (37.5-41.5)	18.9 (18.5-20.0)	10.8 (9.2-11.0)	9.2 (8.5-9.8)	7.6 (7.0-8.0)	21.6 (20.5-22.2)	19.1 (17.0-20.2)
10	<i>Geospiza s. intermedia</i>	Indefatigable	68.1 (66.0-70.5)	40.6 (38.5-42.5)	19.7 (18.8-21.2)	11.4 (10.5-12.0)	9.2 (8.5-10.0)	7.6 (7.2-8.0)	21.4 (20.2-23.5)	19.5 (18.0-21.0)
8	<i>Geospiza s. intermedia</i>	Chatham	64.4 (61.5-67.2)	39.8 (38.5-42.0)	17.3 (16.8-18.0)	9.7 (8.8-10.8)	10.1 (9.2-11.5)	8.1 (7.2-9.0)	20.6 (20.0-21.2)	18.4 (18.0-19.0)
3	<i>Geospiza s. intermedia</i>	Harrington	67.2 (64.5-70.5)	40.4 (39.0-44.0)	19.1 (17.5-20.0)	11.2 (10.2-12.0)	9.7 (8.8-10.5)	7.8 (7.0-8.2)	21.7 (20.8-22.5)	19.3 (18.0-20.0)
10	<i>Geospiza s. intermedia</i>	Charles	66.8 (63.0-70.0)	41.5 (35.2-44.5)	17.4 (16.2-18.5)	10.1 (9.2-11.0)	8.9 (8.5-9.5)	7.4 (7.0-8.0)	21.2 (20.8-22.0)	19.2 (18.5-20.0)

85. *Geospiza conirostris conirostris* Ridgway

Geospiza conirostris Ridgway, 1890, p. 106, fig. 2 (Hood Island; orig. descr.); 1897, p. 516; 1901, p. 498.—Gifford, 1919, p. 225, part.
Geospiza conirostris conirostris Rothschild & Hartert, 1899, p. 158; 1902, p. 389.—Snodgrass & Heller, 1904, p. 344.
Geospiza media Ridgway, 1890, p. 107 (Hood Island; orig. descr.); 1897, p. 517.

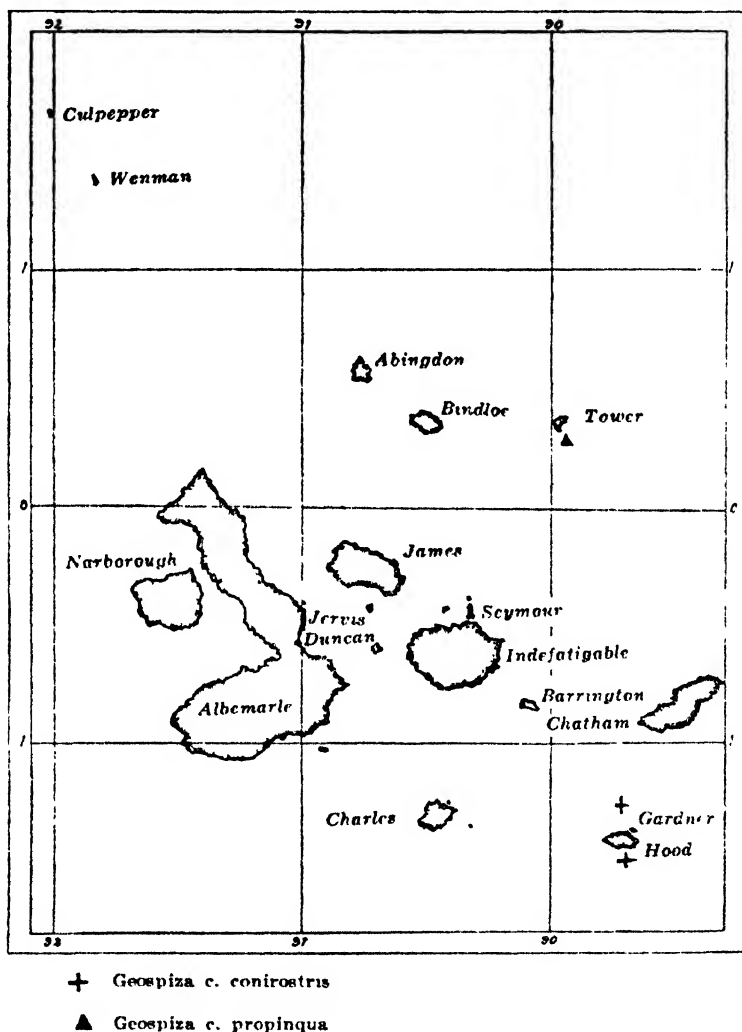


Fig. 40. Map showing distribution of subspecies of *Geospiza conirostris*. Symbols indicate islands where recorded.

GEOSPIZA CONIROSTRIS Ridgway

Type.—United States National Museum, no. 116070; ♂ ad.; Hood Island; April 7, 1888; U. S. S. Albatross.

GEOSPIZA MEDIA Ridgway

Type.—United States National Museum, no. 116072; (♂ ad.); Hood Island; April 7, 1888; U. S. S. Albatross.

DESCRIPTION.—Of large size (wing 74-84 mm.) and with very heavy bill (about as deep as in *magnirostris* but relatively longer and much compressed laterally). *Adult male*.—Uniform black except that the under tail coverts are more or less broadly margined with whitish. *Adult female*.—Dull black, solidly so on head, neck, breast and back, and occasionally over most of belly. Usually with feathers of belly and sides broadly black centrally, narrowly

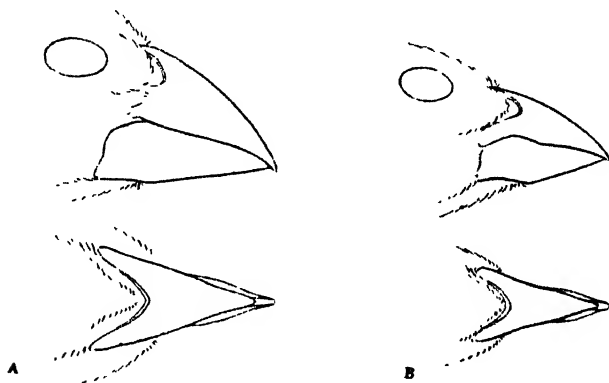


Fig. 41. *Geospiza conirostris conirostris*, males:
a (no. 5007), Hood; b (no. 4990), Gardner-near-Hood. Natural size.

edged with whitish, producing a streaked effect. Under tail coverts mostly whitish, with a narrow central streak of dusky. Remiges and rectrices uniform black; wing coverts narrowly edged with rusty. *Streaked male*.—Exactly like adult female. Rump sometimes grayish or olivaceous, and belly rarely rather extensively whitish, to a variable degree. *Juvenal*.—Closely similar to adult female and streaked male, being dull black, obscurely streaked below, feathers of dorsum sometimes faintly edged with olivaceous, and wing coverts with rusty.

HABITAT.—Hood and Gardner-near-Hood islands.

There are at hand 184 skins in the Academy collection (nos. 4989-5095, 5097, 5098, 6689-6759, 6864-6867) and 29 from the Stanford University collection, taken upon Hood Island and upon Gardner-near-Hood (see table, p. 206). They were collected on the following dates. Hood: January 31, February 1-5, May 13-19, June 23-28, July 2, September 25-27, October 2. Gardner-near-Hood: February 3, May 17, June 27, September 28-30.

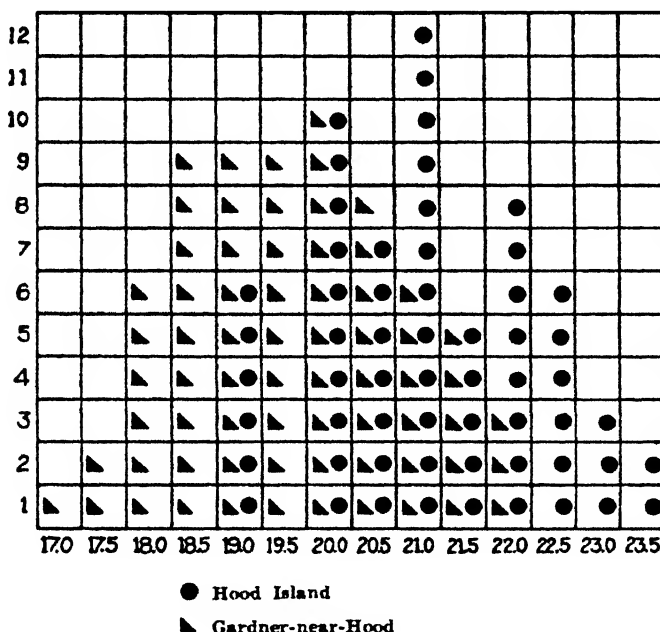


Fig. 42. Length of culmen in male specimens of *Geospiza conirostris*: 59 from Hood Island, 68 from Gardner-near-Hood. Each symbol represents a specimen. Numerals at left of diagram indicate number of specimens; numerals at bottom, length of culmen in millimeters.

Color of bill varies as follows. Black males: January, black: February, mostly black, some with lower mandible partly pale colored; May, black: June, pale colored below, with blotches of dusky above: September, mostly as in June, several entirely black: October, of five specimens three have the bill black, two mostly black. Streaked males: February, of nine birds, the bill is black in one, and dusky above, mostly pale colored below, in eight:

June to October, mostly pale colored below, blotched above. Females: February, mostly black or dusky, a few parti-colored below; May, black; June to September, mostly pale colored below, blotched above. In no case is the bill entirely pale colored; even birds in juvenal plumage have the upper mandible blotched with dusky.

The great variability in bill structure that is shown in this form has been commented upon by others (see Ridgway, 1897, p. 518; Snodgrass & Heller, 1904, p. 342), and it is well borne out in the Academy series. It is a striking fact, though, that in our two almost equally large series from Hood Island and from Gardner-near-Hood, respectively, large billed birds should predominate, and to a noticeable degree, in the series from Hood, small billed ones in the series from Gardner. The latter, a tiny islet, is so slightly removed from the larger Hood Island that it is hard to believe that these size differences have real genetic significance. Gifford (1919, p. 226) remarks that "finches were seen flying between Hood and Gardner quite often and doubtless some belonged to this species," corroborative of the idea that the birds can not be segregated upon either island. The fact remains, however, that there is an appreciable difference in bill size in the two lots. The accompanying diagram (p. 203) illustrates the point.

86. *Geospiza conirostris propinqua* Ridgway

Geospiza propinqua Ridgway, 1894, p. 361 (Tower Island; orig. descr.); 1897, p. 543; 1901, p. 499.—Hartert, 1919, p. 152 (particulars of type specimen, in Rothschild Museum).

Geospiza conirostris propinqua Rothschild & Hartert, 1899, p. 159; 1902, p. 390.—Snodgrass & Heller, 1904, p. 343.

Geospiza conirostris Gifford, 1919, p. 225, part.

GEOSPIZA PROPINQUA Ridgway

Type.—Rothschild Museum: (♂ ad.); Tower Island: September 2. 1891: Dr. G. Baur: orig. no. 597: "from spirits."

DESCRIPTION.—Generally similar to *G. conirostris* but slightly smaller and with slightly smaller and narrower bill. *Adult male*.—Uniform black except that the under tail coverts are more or less broadly margined with whitish. *Adult female*.—Light phase, essentially similar to female *magnirostris*; dark phase, essentially similar to lighter colored females of *conirostris*. Of eight females at hand, five are light colored and three are dark.

HABITAT.—Tower Island (and Culpepper Island?).

The Academy series includes eight specimens from Tower (nos. 4987, 4988, 6682-6687), Stanford University collection, nine. The Academy series was collected September 14, the Stanford University series on June 22 and 23. In the September birds, two (a black male and an adult female) have the bill dusky, in the others it is mostly pale colored, above and below. In the June specimens the bill in every case is mottled, more or less dusky above, pale colored below.

This form, judging from the relatively small series available, is again distinguished by variability in bill structure. It was described as a slender-billed form and most of our series bear out this character, but in some of our birds and in nearly all of the Stanford University series the bill is short and heavy. Snod-

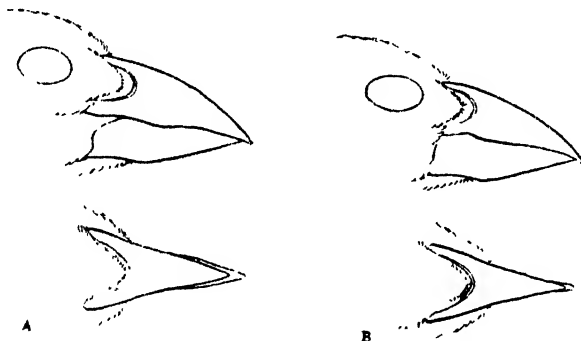


Fig. 43. *Geospiza conirostris propinqua*, males:
a (no. 5281, coll. Stanford Univ.), b (no. 4987), both from Tower. Natural size.

grass & Heller (1904, p. 344) comment upon intergradation shown toward the heavy-billed *G. scandens rothschildi*, and the resemblance is strikingly apparent in the one black male of *propinqua* in the Academy series, but it is not suggested by most of the birds in the Stanford University series, which are decidedly heavy-billed.

Our series includes five females and two streaked males from Tower Island and these do not show the melanism that is so conspicuous in the corresponding plumages of *conirostris*. With one exception they are no darker than is the case in the streaked plumage of *G. magnirostris*.

Just as variability in bill structure seems indicative of intergradation toward the *scandens* group, so the variability in color

in the female plumages (some dark some streaked) seems to show intergradation toward the *magnirostris* group. *Propinqua* is not a satisfactory subspecies from the cataloger's standpoint, as it appears to represent a focus from which lines of resemblance can be drawn toward the extremes of *conirostris*, *magnirostris* and *scandens*. It is an unstable form.

There are two specimens at hand from Culpepper Island that I feel obliged to refer to *propinqua*. A black male in the Stanford University collection has been commented upon by Snodgrass & Heller (*loc. cit.*). A female (no. 6688) was collected on Culpepper by the Academy expedition, on September 25. This bird is somewhat beyond the maximum of *conirostris* and *propinqua* in length of wing and tail; the bill is larger than in *propinqua* but can be closely matched in specimens of *conirostris* from Hood Island. As in Tower Island *propinqua*, it is not particularly dark colored, but with relatively narrow streaks below upon a predominantly pale colored ground. For examples of *propinqua* from Tower Island to stray as far as Culpepper, or to be permanently resident there, does not seem reasonable, and records of such occurrence should rest upon unequivocally typical specimens. This can not be said of either of the Culpepper examples of *propinqua* at hand, but at the same time they can not be even as satisfactorily referred to any other form.

SPECIMENS OF THE *Geospiza conirostris* GROUP IN THE ACADEMY COLLECTION AND
(FIGURES IN PARENTHESES) IN THE STANFORD UNIVERSITY COLLECTION

Name	Island	Male (black)	Male (streaked)	Female	Young	Sex unde- termined
<i>Geospiza c. conirostris</i>	Hood	31 (10)	16 (2)	29 (2)	(7)	3
<i>Geospiza c. conirostris</i>	Gardner-near-Hood	29 (5)	34	42 (1)	(2)	
<i>Geospiza c. propinqua</i>	Tower	1 (6)	2 (1)	5 (2)		
<i>Geospiza c. propinqua</i>	Culpepper	(1)		1		

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM) OF
Geospiza c. conirostris AND *G. c. propinqua*

MALES

Number of specimens	Name	Island	Wing	Tail	Culmen	Gonys	Depth of bill at base	Width of mandible at base	Tarsus	Middle toe with claw
10	<i>Geospiza c. conirostris</i>	Hood Gardner-	78.2 (74.0-83.5)	47.7 (44.5-50.0)	21.3 (19.0-23.5)	12.9 (11.2-12.8)	16.4 (14.5-18.5)	12.2 (11.0-13.0)	23.6 (22.5-24.2)	22.8 (22.0-24.0)
10	<i>Geospiza c. conirostris</i>	near-Hood Gardner-	77.1 (74.0-79.5)	47.5 (45.5-51.0)	19.6 (18.0-22.0)	11.1 (9.5-12.2)	14.4 (12.5-16.2)	10.9 (9.2-12.2)	23.0 (22.0-24.0)	21.7 (20.0-23.5)
9	<i>Geospiza c. propinqua</i>	Tower	74.3 (72.5-77.0)	46.3 (43.0-48.5)	19.5 (18.0-20.5)	10.9 (10.0-11.2)	12.9 (12.0-14.0)	9.9 (9.5-10.5)	23.3 (23.0-25.0)	21.2 (20.2-23.0)

FEMALES

10	<i>Geospiza c. conirostris</i>	Hood Gardner-	75.7 (72.2-78.0)	44.2 (42.0-46.0)	20.5 (18.5-22.2)	11.7 (11.0-13.2)	15.3 (13.5-17.2)	11.5 (10.0-12.5)	23.2 (22.2-24.0)	22.2 (21.0-23.2)
10	<i>Geospiza c. conirostris</i>	near-Hood Gardner-	73.9 (71.0-76.0)	44.8 (41.2-48.5)	19.0 (17.0-22.0)	11.0 (9.5-12.5)	14.2 (12.5-16.0)	10.7 (9.2-12.5)	22.4 (21.5-23.2)	20.7 (20.0-22.0)
6	<i>Geospiza c. propinqua</i>	Tower	71.6 (71.0-72.2)	43.5 (42.0-44.2)	19.9 (18.5-21.0)	10.3 (10.5-11.0)	12.5 (12.0-14.0)	9.8 (9.0-11.2)	23.4 (22.5-24.5)	21.1 (19.2-22.0)

Genus *PLATYSPIZA* Ridgway

Platyspiza Ridgway, Proc. U. S. Nat. Mus., XIX, no. 1116, March 15, 1897, p. 545. (Type *Camarhynchus variegatus* Sclater & Salvin, = *C. crassirostris* Gould.)

Large finch-like *Geospizidæ* (wing 80-88 mm.); coloration, high-plumaged male usually with head and breast black, sometimes almost entirely black; female and young streaked; bill short, deep and broad, culmen strongly convex, gonys straight; tarsus relatively long, ratio of "middle toe with claw" to tarsus about 8 : 10. (For structural details see Ridgway, 1901, p. 473.)

Platyspiza was proposed by Ridgway (*loc. cit.*) as a subgenus under *Camarhynchus* and used by him later (1901, p. 473) as a genus. Rothschild & Hartert (1899, p. 152) object to the use of the name either as a genus or subgenus, and Snodgrass & Heller, willing to use the name in a subgeneric sense, place *crassirostris* in the genus *Geospiza*. I agree with Ridgway in the conviction that this species is sufficiently distinct both from *Geospiza* and *Camarhynchus* to be placed in another genus. The bill is peculiar, presenting in its shortness, breadth and depth, its strongly convex culmen, and its straight gonys, a combination of characters that is peculiar to this one species. There are other peculiarities of structure and distribution pointing toward the taxonomic isolation of this form.

87. *Platyspiza crassirostris* (Gould)

Camarhynchus crassirostris Gould, 1837a, p. 6 (Galapagos Islands; orig. descr.); 1841, p. 103, pl. 41 (Charles Island).—Salvin, 1876, p. 489.—Sharpe, 1888, p. 16.—Ridgway, 1890, p. 110; 1897, p. 551.

Geospiza crassirostris Rothschild & Hartert, 1899, p. 166.—Snodgrass & Heller, 1904, p. 291.

Camarhynchus variegatus Sclater & Salvin, 1870, pp. 323, 324 (Abingdon and Bindloe islands; orig. descr.).—Salvin, 1876, p. 489, pl. 85, text fig.—Sharpe, 1888, p. 15.—Ridgway, 1897, p. 548.

Platyspiza crassirostris Ridgway, 1901, p. 474.—Gifford, 1919, p. 243.

CAMARHYNCHUS VARIEGATUS Sclater & Salvin

Cotype.—British Museum, no. 85.12.14.542; ♂ ad.; Abingdon Island; December 26-30, 1868; Dr. A. Habel.

Cotype.—British Museum, no. 85.12.14.543; ♂ im.; Abingdon Island; December 18, 1868; Dr. A. Habel.

Cotype.—British Museum, no. 85.12.14.541; ♀; Abingdon Island; (no date); Dr. A. Habel.

Cotype.—British Museum, no. 75.4.2.34; ♂ ad.; Abingdon Island; December 26-30, 1868; Dr. A. Habel.

Cotype.—British Museum, no. 75.4.2.33; ♀; Abingdon Island; (no date); Dr. A. Habel.

Cotype.—British Museum, no. 75.4.2.35; ♀; Bindloe Island; November 4, 1868, Dr. A. Habel.

Cotype.—British Museum, no. 85.12.14.544; ♀; Bindloe Island; November 4, 1868, Dr. A. Habel.

Described from 16 specimens from Bindloe and Abingdon islands (no type indicated), of which 7 are extant in the British Museum. No. 85.12.14.542 now bears a British Museum red "type label."*

The bird listed by Sharpe (1888, p. 16) as the type of *Camarhynchus crassirostris* is, perhaps, an aberrant *C. psittacula*.† Gould's description and plate were from a female or immature male of *crassirostris*, a specimen that apparently has since disappeared. The skin of *psittacula* above-mentioned is a male with some black about the head. There is no reason apparent for attaching it to Gould's descriptive matter, and, in fact, despite Sharpe's statement, it does not now bear a red "type label".

DESCRIPTION.—Among the largest of the *Geospizidæ* (wing about 85 mm.). "Bill short, deep, and broad, with culmen strongly convex, but gonys straight, the latter decidedly shorter than basal width of mandible; maxillary tomium strongly angulated or deflexed basally; mandibular tomium with its decided subbasal angle obviously toothed" (Ridgway, 1901, p. 473).

Adult male.—Head, neck, breast, back, sides, wings, and tail, black, as in *Geospiza*. An irregularly defined triangular area on the lower belly white, from a median point on the breast broadening posteriorly; under tail coverts white. Feathers of flanks black centrally and whitish edged, producing a streaked effect. The extremely dark plumage just described is apparently not frequently attained, though I find it represented in series from different islands. More common is the state described as the adult male by Ridgway (1901, p. 474), in which the head and breast are more or less extensively black or dusky, rather sharply defined against the olivaceous back, streaked sides, and whitish belly. *Adult female*.

*Because it was figured. N.B.K.

†Collected by Fitzroy on James Island. N.B.K.

—A brownish appearing bird. Above olive brown, feathers on top of head and back with dark centers, producing a mottled effect; rump somewhat brighter olive and unstreaked. Remiges and rectrices brownish or dusky, narrowly edged with pale brown or olivaceous. Wing coverts edged with pale brown, producing ill-

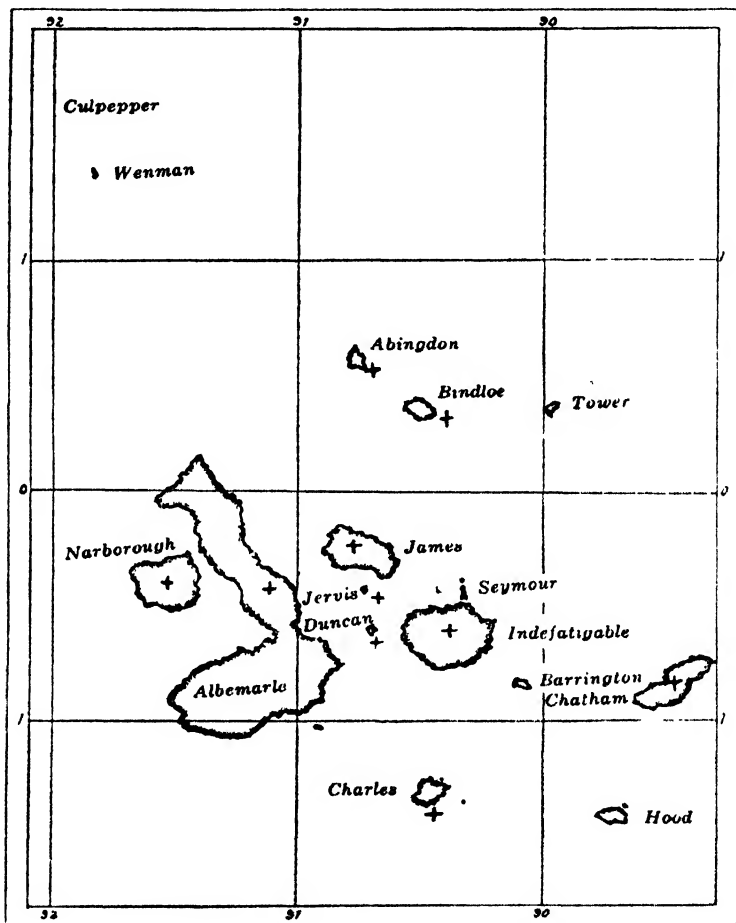


Fig. 44. Map showing distribution of *Platyspiza crassirostris*. Symbols indicate islands where recorded.

defined bars across the wing. Under parts whitish or pale creamy yellow, heavily streaked with brownish over breast and sides. Center of belly and under tail coverts immaculate. *Streaked male*.—Essentially similar to the adult female. In this plumage

every degree of variation is shown, from specimens indistinguishable from the female, through others showing a progressively increasing amount of black upon the head and throat, and thus grading into the black breast and the almost totally black (presumably "perfect plumaged") males. *Juvenal* (sexes alike).—Essentially like the adult female, though with feathers on back and wings perhaps more broadly margined with brownish, and in some cases with streakings on breast and throat tending to coalesce, giving a dusky-headed appearance. In some cases the ventral streakings are almost absent.

Recorded from the following islands: Abingdon, Bindloe, Albemarle, Narborough, James, Jervis, Duncan, Indefatigable, Chatham,



Fig. 45. *Platyspiza crassirostris*, male (no. 8401), Charles. Natural size.

and Charles. Found in fair abundance upon all of those islands by the Academy expedition (Gifford, 1919, p. 243). A total of 246 specimens was collected (nos. 8399-8644).

The adult male of this species is described by Ridgway (1901, p. 474) as having the black confined more or less to the head, neck, and upper chest, the back being brownish olive, the belly mostly whitish or yellowish. Our series shows that the extent of the black is extremely variable, the darkest colored males having the upper parts, wings and tail, almost uniformly sooty black, while below the black invades all but the center of the lower abdomen, and the lower tail coverts. Two of the three adult males from Charles are colored thus, as are others from James, and some, slightly less intensely black, from Indefatigable and Albemarle. Four adult males collected on James Island in August have light colored bills, while all but one of the adult males that were taken

there in December and January (the breeding season) have the bill black or dusky. In general, birds a year or more old taken from December to June have the bill dark colored or black, while those taken from July to November have it mostly lighter colored.

Male and female in juvenal plumage are alike, in a streaked plumage similar to that of the adult female. Following the post-juvenal molt the male bird on some of the islands, but apparently not on all, is streaked, and is generally similar to the adult female, and it breeds in this plumage. The fully mature male may or may not be black-headed, often almost entirely black, but this black-headed plumage is not a sharply defined stage, definitely following a certain molt. Long series of males from any one island show a number of intermediate steps, leading by degrees from the streaked to the mostly black plumage. Whether these steps are passed, year by year, by all alike, or whether individuals vary in the amount of black that is ever attained, are unsolved problems.

The question enters here of there being subspecific difference in this regard between forms on some of the islands. Thus, in the series of nineteen males from James Island there is considerable variation between the least black and the most extensively black specimens, but even the least black is sharply differentiated from the streaked female. Although it can not be doubted that some of the duller colored birds from James Island are of the same age as streaked males from other islands, they have all assumed a noticeably black plumage. On the other hand, of the twenty males from Chatham, only two are black-headed in any degree, and those only as much so as the duller of the James Island birds. The scarcity of black-headed birds upon Chatham is commented upon by Gifford (1919, p. 246). From Charles Island, too, we have only three black-headed males, but two of these are among the most extensively black-marked of any of the entire series.

There are other features that may prove to be of taxonomic significance, such as the relative grayness or green-ness of the olivaceous-backed males on different islands, and the breadth of streaking below on females and immatures, but individual variation in series from any one island is too great to justify one in claiming even a tendency in such particulars to exist at any specified locality. There is one molt a year, extending, in different indi-

viduals, through March, April, and May, occasionally into June. Birds in juvenal plumage were collected during March, April, and May. The plumage is affected noticeably by wear and fading, so that for close comparison it is essential to have birds taken at the same season upon different islands. Our series, large as it is, does not contain birds from all of the islands that are exactly comparable, seasonally, and allowance must accordingly be made in any conclusions that are drawn. Measurements do not disclose any size differences of taxonomic value.

SPECIMENS OF *Platypiza crassirostris* IN THE ACADEMY COLLECTION
AND (FIGURES IN PARENTHESES) IN THE STANFORD
UNIVERSITY COLLECTION

Island	Male (black-headed)	Male (non-black-headed)	Female	Young	Sex undetermined
Abingdon	(3)	5 (1)	3 (2)		
Bindloe	3	1 (1)	3 (2)		
Bindloe	3	1 (1)	3		
James	14 (1)	5 (1)	8		3
Albemarle	18 (5)	14	29 (1)	26	
Narborough	(5)		(4)	(1)	(1)
Duncan			(1)		
Indefatigable	10	4	24		1
Charles	2	14	25	2	4
Chatham	2	18 (3)	5 (1)		1 (2)

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM) OF
Platypiza crassirostris

MALES

Number of specimens	Island	Wing	Tail	Culmen	Gonyx	Depth of bill at base	Width of mandible at base	Tarsus	Middle toe with claw
5	Abingdon	81.5 (80.3-83.0)	53.8 (51.2-55.5)	14.3 (14.0-14.5)	7.2 (7.0-7.5)	12.1 (12.0-12.5)	9.4 (9.0-10.0)	27.3 (27.0-28.0)	22.1 (21.2-23.0)
3	Bindloe	84.2 (83.0-86.0)	54.8 (53.5-56.0)	14.3 (13.5-15.5)	7.3 (7.0-7.5)	12.8 (12.5-13.0)	10.0	28.5 (28.0-29.5)	23.3 (23.0-23.5)
10	James	86.4 (84.0-88.5)	56.1 (53.0-59.5)	14.8 (14.0-15.0)	7.6 (7.0-8.0)	12.8 (12.0-13.5)	10.1 (10.0-10.5)	28.0 (27.0-29.0)	22.2 (20.5-24.0)
10	Indefatigable	84.9 (83.0-86.0)	55.8 (54.0-57.5)	14.4 (14.0-15.5)	7.7 (7.5-8.0)	12.2 (11.5-12.5)	9.8 (8.5-10.5)	27.8 (26.5-28.5)	22.0 (20.5-23.0)
10	Albermarle	82.9 (80.0-85.0)	54.5 (53.0-56.0)	14.5 (13.5-16.0)	7.2 (6.5-8.0)	12.2 (11.5-12.5)	9.6 (9.0-10.0)	27.9 (26.0-29.5)	22.3 (21.0-23.0)
10	Chatham	83.6 (81.0-86.5)	54.6 (52.2-56.5)	15.3 (14.0-16.5)	7.7 (7.0-8.0)	12.8 (12.0-14.0)	10.0 (9.8-10.2)	27.7 (26.0-28.5)	22.8 (21.5-23.5)
10	Charles	84.3 (81.2-87.5)	54.1 (51.5-57.0)	15.1 (14.0-16.5)	7.5 (7.2-8.0)	12.6 (12.0-14.0)	9.9 (9.5-10.5)	27.4 (26.5-28.0)	22.0 (21.5-23.0)

FEMALES

5	Abingdon	78.9 (77.0-82.0)	52.8 (51.0-54.5)	15.0 (14.5-15.5)	7.2 (7.0-7.8)	11.8 (11.2-12.5)	9.3 (9.2- 9.8)	27.1 (26.5-27.5)	21.7 (20.5-22.5)
5	Bindloe	80.2 (79.5-81.2)	53.9 (52.0-56.2)	15.1 (14.5-16.0)	7.2 (7.0-7.5)	12.4 (12.0-13.0)	9.9 (9.5-10.0)	27.2 (26.8-27.5)	20.8 (20.2-21.8)
8	James	81.8 (79.0-85.8)	53.3 (51.0-56.0)	14.9 (14.2-15.0)	7.2 (7.0-7.5)	11.7 (11.2-13.2)	9.5 (9.0-10.2)	27.5 (27.0-28.5)	21.9 (20.0-23.2)
10	Indefatigable	80.9 (75.8-85.5)	52.8 (51.0-55.5)	14.9 (13.0-16.2)	7.0 (6.5-7.2)	11.9 (11.0-12.5)	9.5 (9.0-10.2)	27.3 (26.0-28.5)	21.3 (20.0-23.0)
10	Albermarle	80.5 (75.8-84.0)	52.8 (50.5-55.5)	14.8 (14.2-15.2)	7.1 (7.0-7.2)	11.8 (11.2-12.2)	9.4 (9.0-10.0)	27.7 (27.0-28.2)	21.4 (20.5-23.2)
6	Chatham	80.5 (78.0-84.0)	53.7 (52.0-55.5)	15.4 (14.0-16.0)	7.4 (6.5-8.0)	12.2 (11.5-12.5)	10.0 (9.5-10.5)	27.2 (26.0-28.5)	22.1 (21.2-23.0)
10	Charles	81.9 (80.0-84.2)	53.9 (50.8-56.2)	15.2 (14.2-17.0)	7.5 (7.2-8.0)	12.0 (11.5-12.5)	9.7 (9.2-10.5)	26.6 (26.0-27.5)	21.4 (20.0-22.5)

Genus CAMARHYNCHUS Gould

Camarhynchus Gould, Proc. Zool. Soc. London, part V, 1837a, p. 6.
(Type, *Camarhynchus psittacula* Gould.)

Small and medium sized finch-like Geospizidæ (wing 58-75 mm.); coloration, high plumaged males usually with head and breast black (two species with no black markings), female and young streaked below or nearly immaculate below; one species with chestnut on throat; bill usually short and stout, laterally compressed, culmen convex (usually strongly so), gonys slightly to strongly convex; tarsus relatively long, ratio of "middle toe with claw" to tarsus about 8 : 10.

88. *Camarhynchus psittacula* Gould

Camarhynchus psittacula Gould, 1837a, p. 6 (Galapagos Islands; orig. descr.).

Camarhynchus psittaculus Gould, 1841, p. 103, pl. 40 (James Island).—Selater & Salvin, 1870, p. 323 (Indefatigable).—Salvin, 1876, p. 488.—Sharpe, 1888, p. 16.—Ridgway, 1890, p. 109; 1897, p. 552; 1901, p. 477.—Gifford, 1919, p. 246.

Geospiza psittacula psittacula Rothschild & Hartert, 1899, p. 167; 1902, p. 400.—Snodgrass & Heller, 1904, p. 290.

Camarhynchus townsendi Ridgway, 1890, p. 110, fig. 5 (Charles Island; orig. descr.).

Geospiza psittacula townsendi Rothschild & Hartert, 1899, p. 167.—Snodgrass & Heller, 1904, p. 291.

Camarhynchus rostratus Ridgway, 1894, p. 363 (James Island; orig. descr.).

Camarhynchus compressirostris Ridgway, 1896, p. 294 (Jervis Island; orig. descr.); 1897, p. 558; 1901, p. 481.—Hartert, 1919, p. 153 (particulars of type specimen, in Rothschild Museum).

CAMARHYNCHUS PSITTACULA Gould

Cotype.—British Museum, no. 55.12.19.22; (♀?; Galapagos Islands); "ex coll. Darwin."

Cotype.—British Museum, no. 55.12.19.12; (♀?; Galapagos Islands); "ex coll. Darwin."

No. 55.12.19.22 bears a red "type label."

CAMARHYNCHUS TOWNSENDI Ridgway

Type.—United States National Museum, no. 115915; ♂ (in female plumage); Charles Island; April 8 (1888); U. S. Fish Commission, Voyage of the Albatross, 1887-88.

CAMARHYNCHUS ROSTRATUS Ridgway

Type.—United States National Museum, no. 116006; ♂ ad.; James

Island; April 11 (1888); U. S. Fish Commission, Voyage of the Albatross, 1887-88.

CAMARHYNCHUS COMPRESSIROSTRIS Ridgway

Type.—Rothschild Museum; ♀ ad.; Jervis Island; August 8, 1891; Dr. G. Baur; orig. no. 471.

DESCRIPTION.—Largest of the genus *Camarhynchus* (wing about 70 mm.). Culmen sharply decurved (parrot-like) and gonys markedly convex, up-curved. "Bill short and stout, its depth at base much exceeding distance from nostril to tip of maxilla, and width at base usually decidedly greater than length of gonys, never decidedly less" (Ridgway, 1901, p. 477). *Adult male*.—Head, neck and chest black; feathers of dorsum black, narrowly edged with greenish olivaceous; black area below extending farther back on sides than on breast, and passing into longitudinal black streaks; center of belly and under tail coverts white; flanks grayish olive; remiges, wing coverts, and rectrices black, narrowly edged with olivaceous. The specimen described is one of several representing the darkest extreme in the series. In another stage the black head is more sharply defined against a grayish dorsum, and there are others showing progressive diminution of the black area on head and breast, grading into a plumage that is closely similar to the adult female, though always with some black on face and throat. There is great variation, out of proportion to the number of adult males in the series. *Adult female*.—In general appearance gray-brown above, whitish below. On upper parts, grayish on pileum, more brownish on dorsum, passing into olivaceous brown on rump. Feathers of pileum dusky-streaked centrally, feathers of dorsum dark centered. A poorly defined whitish superciliary line and whitish area about eye. Dark color of upper parts extending to ear coverts and sides of neck, where blending into the whitish ventral surface. Flanks and belly faintly tinged with buffy or yellow. Rectrices and remiges dusky, narrowly edged with olivaceous; greater and median wing coverts broadly edged with grayish or whitish. Variants among females are practically immaculate below, are tinged more or less strongly with yellow over the whole lower area, have faintly indicated nebulous streaks on breast and sides, or have ventral streaks distinct and sharply defined. *Juvenal*.—Not represented in our series.

HABITAT.—James, Jervis, Seymour, Indefatigable, Duncan, Barrington, and Charles.

The Academy series consists of 34 specimens (nos. 8342, 8360, 8362, 8363, 8366, 8370-8398). Of the James Island birds, six were collected in December, five in January, and two in August. Nine males taken during December and January vary from an extremely black condition, involving head, breast, flanks and even

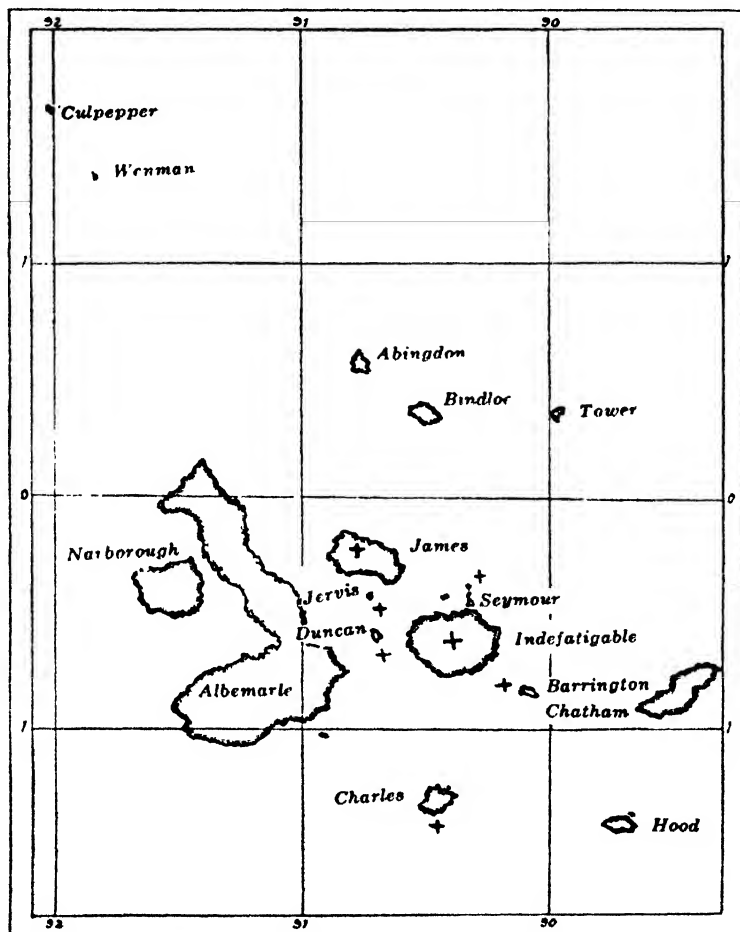


Fig. 46. Map showing distribution of *Camarhynchus psittacula*. Symbols indicate islands where recorded.

the back, through various intermediate stages to a condition where there are only small patches of black on head and throat. A male collected in August lies about midway between the extremes. December and January birds, both sexes, have the bill black, with the

exception of one (no. 8382), sex unknown, that is in the midst of the molt, and has a light colored bill. The two August specimens, male and female, respectively, have the bill light colored.

Of the nine specimens from Charles Island, five were collected in October, four in May. In seven of the nine the bill is light colored, in two, a male taken on October 5, and a female on May 29, it is dusky (not black). One of the two males has a good deal of black on forehead, throat, and upper breast; the other has traces of black on face and throat. Four specimens from Indefatigable were collected on July 11, 12, 17, and November 14, respectively. The three July birds (including a black-headed male) have the bill light colored; in the November specimen, an adult female, it is black. Five from Duncan were collected August 14 and 15. The two males are in the non-black female plumage. All have light colored bills. From Jervis there are two, both collected December 21, a very black male with black bill, an adult female with light colored bill. The one Barrington skin is an adult female, collected October 20. It has a light colored bill.

Psittacula and *affinis* are closely similar, so much so that it seemed to me at first that they should be treated as only subspecifically different. The objection to this course lies in the occurrence of *affinis* on James Island and on Seymour (hence by inference, on Indefatigable also), within the habitat of *psittacula*; although *affinis* is apparently rare on those islands, its occurrence there at all debars treatment of the two forms as only subspecifically different.

An added complication in this matter is found in the supposed *Camarhynchus compressirostris* (Ridgway, 1896, p. 294), described from Jervis Island. This form was based upon a single bird, a female, and has been recognized by no one except the describer. We have two birds of the *psittacula* type from Jervis Island, male and female, respectively, collected December 21 (nos. 8373, 8387). The male (black headed) is indistinguishable from James Island *psittacula*. The female is a smaller bird with a much smaller bill, but falls within the range of variation that is found on other islands. There is no ground here for the recognition of the form *compressirostris* and I am unable to supply any evidence upholding the existence of that species. Birds from Duncan Island are intermediate between *psittacula* and *affinis*.

Birds from Charles Island are distinctly gray colored and small

billed, enough so, so far as our small series (nine birds) goes, to justify the use of a separate name. Ridgway (1890, p. 110) based his *Camarhynchus townsendi* upon two specimens from Charles Island that exhibited the same sort of variation. My reason for not treating the Charles Island form under a distinct name, as a subspecies, *Camarhynchus psittacula townsendi*, is to be found in the parallel variation that occurs in *C. parvulus*. There, again, there are extremes of color, grayish and greenish, distinguishing series from different islands, but in the one really extensive series (which happens to be from Charles Island) both types of color are represented. It seems a fair assumption that a larger series of *psittacula* from Charles might show a similar range of variation.

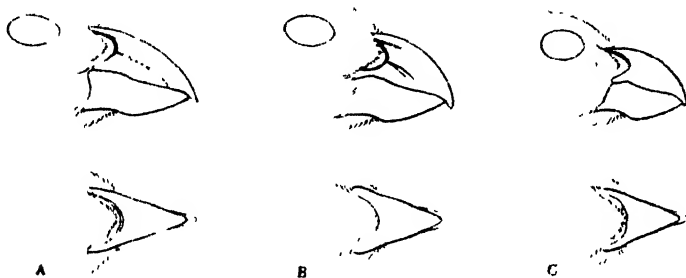


Fig. 47. a, *Camarhynchus habeli* (no. 8279), Bindloe; b, *Camarhynchus psittacula* (no. 8370), James; c, *Camarhynchus affinis* (no. 8333), Albemarle; male birds. Natural size.

89. *Camarhynchus habeli* Sclater & Salvin

Camarhynchus habeli Sclater & Salvin, 1870, pp. 323, 325 (orig. descr.; Abingdon and Bindloe islands).—Salvin, 1876, p. 490, fig.—Sharpe, 1888, p. 17.—Ridgway, 1890, p. 110; 1897, p. 555; 1901, p. 480.—Gifford, 1919, p. 247.

Geospiza habeli Rothschild & Hartert, 1899, p. 168; 1902, p. 401.—Snodgrass & Heller, 1904, p. 238.

Camarhynchus bindloei Ridgway, 1896, p. 294 (orig. descr.; Bindloe Id.); 1897, p. 556.—Hartert, 1919, p. 153 (particulars of type specimen, in Rothschild Museum).

CAMARHYNCHUS HABELI Sclater & Salvin

Cotype.—British Museum, no. 75.4.2.36; ♂ ad.: Abingdon Island; December 14-30. 1868; Dr. A. Habel.

Cotype.—British Museum, no. 75.4.2.37; ♀; Abingdon Island; December 16-30. 1868; Dr. A. Habel.

Cotype.—British Museum, no. 85.12.14.546; (♂); Abingdon Island; December 14-30, 1868; Dr. A. Habel.

Cotype.—British Museum, no. 85.12.14.547; sex?; Abingdon Island; December 16, 1868; Dr. A. Habel.

Cotype.—British Museum, no. 85.12.14.548; (♂); Bindloe Island; November 12, 1868; Dr. A. Habel.

No. 85.12.14.548 now bears a red "type label."

CAMARHYNCHUS BINDLOEI Ridgway

Type.—Rothschild Museum; ♂ ad.; Bindloe Island; September, 1891; Dr. G. Baur; orig. no. 696.

Camarhynchus habeli Sclater & Salvin was described from seven specimens, three from Bindloe and four from Abingdon, no type indicated. Sharpe (1888, p. 17) lists five skins as in the British Museum, one from Bindloe and four from Abingdon, which are still there. He indicated specimens "a" and "b", from Abingdon, as the types, and although there is no way of telling which skins those were, his statement fixes the type locality as Abingdon. This is confirmed by Ridgway, in naming the Bindloe bird. At present the one Bindloe skin has been mistakenly segregated, with a red label, as the "type" of *habeli*.

DESCRIPTION.—Differs from *C. psittacula* only in differently shaped, less sharply decurved, bill. "The culmen longer and gonys at same time shorter, the gonydeal angle more pronounced" (Ridgway, 1901, p. 480). In color and markings there are no differences between *habeli* and *psittacula*. In our *habeli* series, however, there are numerous adult males in plumage indistinguishable from the female, a condition that is not found in our *psittacula* series. *Juvenal*.—Not represented in our series.

HABITAT.—Abingdon and Bindloe islands.

There are at hand twenty-four specimens from Abingdon, twenty-five from Bindloe (nos. 8278-8326). Those from Abingdon were collected September 18 to 22, those from Bindloe on September 17 and 18. Of the Abingdon birds, three females have the bill black; in the other twenty-one specimens it is light colored. Of the Bindloe birds, seven males (all the black-headed ones) and two females have the bill black, in one male and three females it is dusky, in seven males and five females it is light colored.

Ridgway (1896, p. 294) described *Camarhynchus bindloei* from

Bindloe Island, differing from *habeli*, of Abingdon, in being "rather larger, with decidedly larger bill, the latter with culmen much less compressed." *Bindloei* has not been recognized by others, and

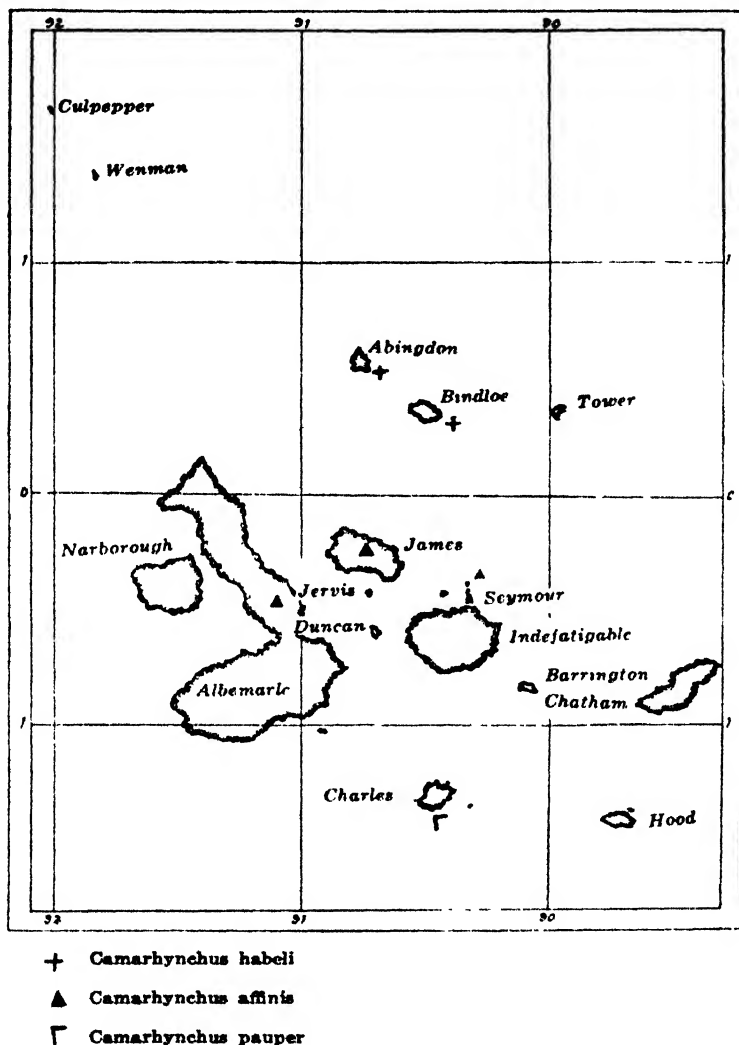


Fig. 48. Map showing distribution of *Camarhynchus habeli*, *C. affinis*, and *C. pauper*. Symbols indicate islands where recorded.

Ridgway, himself (1901, p. 480) reduced it to a synonym of *habeli*. I can not, myself, see the structural differences described, nor are

there any differences of color and pattern, in comparable plumages, between birds from the two islands. There is, however, a notable difference in the manner of occurrence of black-headed males. From Abingdon, not one of our series has a black head, from Bindloe, seven out of fifteen are thus marked. This can not be taken as a fortuitous circumstance, but is, I believe, an indication of conditions as they actually are upon the two islands. Gifford (1919, p. 247), in his published field notes upon this collection, states "I noticed but one black-headed one on Abingdon". Snodgrass & Heller (1904, p. 289) say: "Immature birds common on Abingdon, but adults rare, only two having been seen." Conditions in this regard are thus parallel to what occurs in other species upon Abingdon Island.

90. *Camarhynchus affinis* Ridgway

Camarhynchus affinis Ridgway, 1894, p. 365 (Albemarle Island; orig. descr.); 1897, p. 554; 1901, p. 481.—Gifford, 1919, p. 247.—Hartert, 1919, p. 153 (particulars of type specimen, in Rothschild Museum).

Geospiza affinis Rothschild & Hartert, 1899, p. 168.—Snodgrass & Heller, 1904, p. 289.

Geospiza psittacula affinis Rothschild & Hartert, 1902, p. 401.

Camarhynchus incertus Ridgway, 1896, p. 294 (James Island; orig. descr.); 1897, p. 560; 1901, p. 482.—Hartert, 1919, p. 153 (particulars of type specimen, in Rothschild Museum).

Geospiza incerta Rothschild & Hartert, 1899, p. 168; 1902, p. 401.—Snodgrass & Heller, 1904, p. 289.

CAMARHYNCHUS AFFINIS Ridgway

Type.—Rothschild Museum; (♀ ad.); "Cowley Bay, E. Albemarle, on mountain;" August 10, 11, 1891; Dr. G. Baur; orig. no. 598.

CAMARHYNCHUS INCERTUS Ridgway

Type.—Rothschild Museum; ♀ ad.: James Island; August 13, 1891; Dr. G. Baur; orig. no. 521.

DESCRIPTION.—Differs from *C. psittacula* in smaller size and in smaller and less sharply decurved bill. Differs from *C. habeli* in smaller size and in smaller and slightly less elongated bill. In color and markings there are no differences in adult and near adult plumages, between the three species. I have not seen the juvenal plumage of *psittacula* and *habeli*. *Juvenal*.—Above, general appearance brownish; top of head almost uniformly dusky; dorsum olivaceous, the feathers dusky centered, producing a mottled effect;

rump and upper tail coverts more nearly uniform olivaceous; a poorly defined yellowish area above the eye; cheeks and ear coverts olivaceous, flecked with dusky; below, ground color whitish, tinged with yellowish or buffy, nearly immaculate on throat and entirely unmarked on mid-belly and under tail coverts, otherwise heavily marked with broad, dusky, longitudinal streaks; rectrices and remiges dusky, narrowly edged with olivaceous; wing coverts dusky, broadly edged with olivaceous; bill (in dried skin) light brown; legs and feet blackish.

HABITAT.—Common upon Albemarle and perhaps upon Narborough; probably of only casual occurrence elsewhere, as on James and Seymour.

Represented in our collection by thirty-six skins from Albemarle, two from James, and one from Seymour (nos. 7848, 8327-8341, 8343-8348, 8350-8359, 8361, 8364, 8365, 8467-8469). The series from Albemarle includes seven adult males (only one with black head), nineteen adult females, five birds in juvenal plumage throughout, and five in process of the post-juvenal molt.

In the juvenal plumage the bird is heavily streaked below except on the middle of the lower abdomen and on the lower tail coverts, there are obscurely indicated streaks on the dorsal surface, and the general coloration on head and back is darker than in the succeeding stage. The bill is light colored. This plumage is represented in birds collected from March 19 to April 12. In the following plumage most of the ventral streaking is lost and the whole bird is paler colored. Some individuals retain faintly indicated streaks on the upper breast, which later in the year become more distinct when the feathers get worn. In this plumage male and female are alike, grayish olive above, grayish white below, under parts sometimes immaculate but usually with obscure streaks on breast and flanks. Birds of both sexes in this plumage taken in March have the bill black; some collected late in March and in April have the bill paler colored.

This plumage, heretofore regarded as an immature stage in the male, is worn at least two years by some individuals of that sex, possibly for an indefinite period by some. Males in this plumage a year old or more, taken during March and beginning the annual molt, show new white feathers coming in on throat and upper breast.

The one high plumaged specimen in the series (sex not indi-

cated, but presumably a male) has the top of the head blackish and there are black feathers edged with whitish covering most of the sides of the head, throat, and upper breast. This bird, collected August 11, has the upper mandible dusky, the lower horn color, the whole much paler colored than in breeding birds.

There are two specimens from James Island, male and female, respectively (nos. 8328, 8357), collected December 28, that presumably represent "*Camarhynchus incertus*" Ridgway (1896, p. 294). The male has some blackish on face and throat, and they both exhibit the olivaceous upper parts and yellowish buff under parts described by Ridgway as characteristic of "*incertus*", a type of coloration that differs from the mode of *affinis*, most examples of which are rather grayish in general tone. There are examples of *affinis* from Albemarle Island, however, which are distinctly yellowish below, and on this basis alone, therefore, I hesitate to recognize "*incertus*" as an established form. The same sort of variation is seen in *parvulus*, James Island examples of which are grayish, those from Indefatigable and Albemarle darker and more greenish. There is one bird from Seymour Island (no. 7848), collected November 22, that I feel obliged to refer to *affinis*. It is a male with no black on the head, and differs from the mode of *affinis* only in that the bill is a trifle smaller than the average in that form. It can be duplicated even in that respect, however, in selected specimens of *affinis*.

91. *Camarhynchus pauper* Ridgway

Camarhynchus pauper Ridgway, 1890, p. 111 (Charles Island; orig. descr.); 1897, p. 559; 1901, p. 483.—Gifford, 1919, p. 249.

Geospiza paupera Rothschild & Hartert, 1899, p. 169; 1902, p. 401.—Snodgrass & Heller, 1904, p. 288.

CAMARHYNCHUS PAUPER Ridgway

Type.—United States National Museum, no. 115913; ♀; Charles Island; April 8 (1888); U. S. Fish Commission, Voyage of Albatross, 1887-88.

DESCRIPTION.—Differs from *psittacula*, *habeli*, and *affinis*, in much smaller, less markedly decurved bill. The adult male is black-headed to a greater or less extent, as in those species, and the adult female and near-adult stages of both sexes are also the same so far as markings are concerned. In color, however, there

is this difference, that in *pauper* the general ground color is, on the average, distinctly of a greenish-olivaceous tinge, while in the related species it is more grayish or dusky.

Juvenal.—Male: Head, chest, and back solidly slaty black, broken by only a few faint flecks of olivaceous; sides and flanks heavily streaked with black; middle of belly narrowly unmarked, whitish, tinged with buffy; under tail coverts buffy, with central dusky stripes; remiges and rectrices blackish, narrowly edged with olivaceous; wing coverts broadly edged with rusty; bill (in dried skin) pale brown; feet dusky. There are several young males at hand in this black-headed plumage, but no young females. Other young males are streaked (as in young *affinis*) and all the young females are in this streaked plumage. Mature males not in the black-headed plumage, and mature females, are similar in markings to

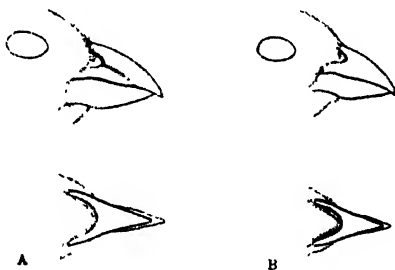


Fig. 49. a, *Camarhynchus pauper* (no. 8123), Charles; b, *Camarhynchus parvulus parvulus* (no. 7756), Indefatigable; male birds. Natural size.

those plumages as described under *C. psittacula*, and vary in the same way, from a heavily streaked plumage to one that is absolutely unmarked below, and with every degree of streakiness between. As yet we lack the clue as to whether these differences represent a sequence of plumages that is passed through by all individuals or whether they are different phases that persist unchanged throughout the life time of any one bird. There is one specimen at hand that sheds this much light upon the question, that it is molting from the streaked juvenal plumage into a stage with absolutely immaculate under parts, and there are two other specimens that appear to be undergoing the same change.

HABITAT.—Charles Island.

Represented by 155 skins (nos. 8122-8220, 8222-8277), collected

on the following dates: October 7-12; February 28; March 1, 2; May 16, 24-31; June 1-4. Fifteen of the male birds are black-headed to a greater or less extent, ranging from an extreme (shown in five specimens) in which the entire head, neck and upper breast are solidly black, through various lesser degrees to a non black-headed condition, in which black markings remain only as a series of heavy streaks across the upper breast. Black-headed birds were collected during October, February, and March. In specimens taken during February and March the bill is solidly black; in those taken in October it is in some cases light colored, in some dusky, in none as black as in the February and March specimens. In the light colored males and in the females there is the same sort of seasonal variation in bill color. In breeding birds, male and female alike, the bill is black. This color fades to yellowish during the molting season, April to June, and begins to reappear in October. Just how soon the black bill is acquired by birds of the year is not apparent, but presumably by the time they begin to breed.

The juvenal plumage is much darker than some of the succeeding stages. In several young males the head and breast are as "solidly" black as in any adult, and in all cases there is the effect of a blackish head, while the lower surface is heavily marked with broad dusky streaks that leave only the lower abdomen and lower tail coverts unmarked. Young birds all have the bill light colored. One or two young birds are molting into a plumage that is grayish white below, tinged with buffy yellow, and unmarked, or at most with faint streaks on breast and sides.

The molt, annual or post-juvenal, as the case may be, takes place in April and May, but these molts are inadequately represented in our series. It is not possible to follow plumage changes beyond the juvenal with any certainty, due to this dearth of molting birds, and due also to lack of information as to whether any given specimen is a young of the year or older. There are fresh plumaged birds at hand in which the lower parts are immaculate or nearly so, and others that are heavily streaked below. Whether this is individual variation, or representative of distinct plumage stages I can not tell. Breeding males are black-headed in various degree, or else are more or less heavily streaked below. Non-breeding males in fresh plumage are similarly marked, but with the ventral streaks obscured, sometimes entirely hidden, by grayish white

feather edgings that disappear with wear later on. Breeding females are mostly with some streaks on breast and sides, though there are one or two at hand that are practically immaculate. There is another sort of plumage variation also, some of the birds being grayish, others buffy yellow, comparable to the characters ascribed, severally, to *Camarhynchus psittacula* and "*C. incertus*."

SPECIMENS OF *Camarhynchus habeli*, *C. psittacula*, *C. pauper*, AND *C. affinis*, IN THE
ACADEMY COLLECTION AND (FIGURES IN PARENTHESIS) IN THE
STANFORD UNIVERSITY COLLECTION

Name	Island	Male	Male	Female	Young	Sex
		(black-headed)	(non-black-headed)			undetermined
<i>Camarhynchus habeli</i>	Abingdon	(1)	7	17(1)		
<i>Camarhynchus habeli</i>	Bindloe	7(1)	8(1)	9		1
<i>Camarhynchus psittacula</i>	James	10(2)		2		1
<i>Camarhynchus psittacula</i>	Jervis	1		1		
<i>Camarhynchus psittacula</i>	Indefatigable	1		2(1)		1
<i>Camarhynchus psittacula</i>	Duncan		2	1		2
<i>Camarhynchus psittacula</i>	Barrington		(1)	1		
<i>Camarhynchus psittacula</i>	Charles	2		6		1
<i>Camarhynchus pauper</i>	Charles	15(1)	57(1)	52	18(1)	13
<i>Camarhynchus affinis</i>	Albemarle	1(3)	6(1)	18(1)	8	(1)
<i>Camarhynchus affinis</i>	James		1	1		
<i>Camarhynchus affinis</i>	Seymour		1			

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM) OF

Camarhynchus habeli, *C. psittacula*, *C. pauper*, and *C. affinis*

MALES

Number of specimens	Name	Island	Wing	Tail	Culmen	Gonys	Depth of bill at base	Width of mandible at base	Tarsus	Middle toe with claw
7	<i>Camarhynchus habeli</i>	Abingdon	67.1 (65.5-69.0)	40.6 (37.5-42.5)	14.8 (14.2-15.2)	7.7 (7.5-8.2)	10.3 (10.0-11.0)	7.5 (7.2-8.2)	22.9 (22.0-23.5)	19.0 (18.0-20.0)
10	<i>Camarhynchus habeli</i>	Bindloe	69.8 (68.6-72.0)	42.2 (37.2-44.0)	16.1 (14.9-16.5)	7.7 (7.2-8.2)	10.3 (10.0-10.8)	7.9 (7.5-8.2)	22.2 (22.0-23.0)	19.3 (18.0-20.2)
10	<i>Camarhynchus psittacula</i>	James	73.0 (70.5-75.0)	44.9 (43.5-48.0)	14.1 (14.0-14.5)	7.8 (7.5-8.5)	11.3 (11.0-12.0)	8.6 (8.0-9.0)	22.7 (22.5-23.5)	19.6 (18.8-20.5)
1	<i>Camarhynchus psittacula</i>	Indefatigable	74.0	46.0	14.0	7.5	11.2	8.8	22.8	17.5
2	<i>Camarhynchus psittacula</i>	Duncan	67.2-67.2	43.0-44.2	12.5-13.2	7.0-7.2	10.0-10.2	8.0-8.0	22.2-22.2	18.0-18.0
2	<i>Camarhynchus psittacula</i>	Charles	70.5-73.2	42.0-45.0	13.5-14.2	7.5-7.5	10.0-11.0	7.5-8.2	22.0-23.0	17.0-20.2
10	<i>Camarhynchus pauper</i>	Charles	69.6 (68.0-71.0)	43.6 (40.2-46.5)	12.5 (12.0-13.5)	7.0 (6.2-7.5)	8.7 (8.2- 9.2)	6.8 (6.5-7.5)	22.6 (22.0-23.0)	18.0 (17.0-18.5)
7	<i>Camarhynchus affinis</i>	Albemarle	65.0 (62.5-70.0)	40.3 (38.0-43.5)	11.9 (11.5-12.2)	6.3 (6.0-6.8)	9.1 (9.0- 9.2)	7.4 (7.0-7.5)	21.8 (21.0-22.2)	16.7 (16.0-17.0)

FEMALES

10	<i>Camarhynchus habeli</i>	Abingdon	66.3 (63.6-68.2)	40.1 (38.2-42.0)	14.6 (14.0-16.0)	7.9 (7.5-8.2)	10.1 (9.2-11.0)	7.5 (7.2-8.2)	22.1 (21.0-23.8)	18.5 (17.5-19.5)
10	<i>Camarhynchus habeli</i>	Bindloe	66.2 (64.0-68.0)	40.6 (38.0-42.5)	14.8 (14.0-15.5)	7.9 (7.2-8.2)	9.9 (9.5-10.0)	7.7 (7.2-8.0)	21.8 (20.0-23.2)	18.8 (17.5-19.2)
2	<i>Camarhynchus psittacula</i>	James	72.0-73.0	45.0-46.2	14.0-14.8	7.5-8.0	10.2-11.0	8.5-8.5	22.2-23.2	18.0-18.8
1	<i>Camarhynchus psittacula</i>	Jervis	63.5	40.2	13.0	7.2	9.5	7.0	21.0	17.5
1	<i>Camarhynchus psittacula</i>	Duncan	63.5	39.2	12.2	7.0	9.0	7.2	21.0	18.5
3	<i>Camarhynchus psittacula</i>	Indefatigable	66.9 (66.2-67.6)	41.2 (39.5-43.2)	13.1 (12.5-13.8)	7.1 (7.0-7.2)	9.1 (9.0- 9.2)	7.9 (7.8-8.0)	22.2 (21.8-22.5)	19.6 (18.5-19.9)
1	<i>Camarhynchus psittacula</i>	Barrington	71.2	43.0	14.5	8.2	11.5	8.5	23.2	19.0
6	<i>Camarhynchus psittacula</i>	Charles	67.2 (66.0-69.0)	42.2 (40.2-46.2)	13.7 (13.2-14.2)	7.3 (7.2-7.5)	10.4 (10.0-11.0)	8.1 (7.9-8.5)	22.3 (22.0-23.0)	19.5 (18.5-21.5)
10	<i>Camarhynchus psittacula</i>	Charles	66.8 (65.0-70.5)	41.1 (39.0-43.2)	12.3 (11.5-13.5)	6.8 (6.2-7.2)	8.6 (7.8- 9.5)	6.9 (6.5-7.2)	21.7 (20.0-23.5)	17.7 (16.2-18.5)
10	<i>Camarhynchus pauper</i>	Albemarle	64.9 (63.0-67.5)	36.8 (36.0-42.0)	12.3 (11.5-13.2)	6.5 (6.2-7.0)	8.9 (8.5- 9.2)	7.3 (7.0-8.0)	21.7 (20.8-22.8)	17.4 (16.8-18.2)

92. *Camarhynchus parvulus parvulus* (Gould)

Geospiza parvula Gould, 1837a, p. 6 (orig. descr.; Galapagos Islands); 1841, p. 102, pl. 39 (James Id.).—Sharpe, 1888, p. 13, part.—Ridgway, 1897, p. 529, part.

Camarhynchus prosthemelas Sclater & Salvin, 1870, pp. 323, 325, fig. 4 (orig. descr.; Indefatigable Island).—Sharpe, 1888, p. 17.—Salvin, 1876, p. 490, fig.—Ridgway, 1890, p. 110, part; 1901, p. 484.—Gifford, 1919, p. 250, part.

Geospiza prosthemelas Rothschild & Hartert, 1899, p. 169.

Geospiza prosthemelas prosthemelas Snodgrass & Heller, 1904, p. 284.

GEOSPIZA PARVULA Gould

Cotype.—British Museum, no. 55.12.19.194; (♂ ad.; Galapagos Islands); C. Darwin.

Cotype.—British Museum, no. 55.12.19.167; (♀?; Galapagos Islands); C. Darwin.

These two specimens designated by Sharpe (1888, p. 14) as "types of species". The male now bears a red "type label". They are also labelled (presumably by Sharpe) as from Chatham Island, but they are not the Chatham Island form (*salvini*) of this species.

CAMARHYNCHUS PROSTHEMELAS Sclater & Salvin

Cotype.—British Museum, no. 75.4.2.38; ♂ im.; Indefatigable Island, August 26, 1868; Dr. A. Habel.

Cotype.—British Museum, no. 85.12.14.549; ♀; Indefatigable Island; (no date); Dr. A. Habel.

Cotype.—British Museum, no. 85.12.14.550; ♀; Indefatigable Island; September 12 (1868); Dr. A. Habel.

No. 75.4.2.38 now bears a red "type label",* though the other two skins were designated as types by Sharpe (1888, p. 17).

Geospiza parvula was described by Gould (1837, p. 6) as from the Galapagos Islands, the types later indicated by him as from James Island. The name has commonly been assumed to apply to small examples of *Geospiza fuliginosa*, and such a small variety has been recognized by some writers, disallowed by others. In the Catalogue of Birds, Sharpe (1888, p. 14) lists two specimens as the types, entered for no obvious reason as from Chatham Island. These two birds (apparently the originals of Gould's description and colored plate; they match the latter very closely) are adult male and female of the form that was later named *Camarhynchus*

*Because Sclater & Salvin described the male first. N.B.K.

prothemelas by Sclater & Salvin. The male is exceptionally black on the back and the skin is folded so that the white belly is hidden to casual observation. It seems obvious that *Camarhynchus prothemelas* Sclater & Salvin must become *Camarhynchus parvulus*

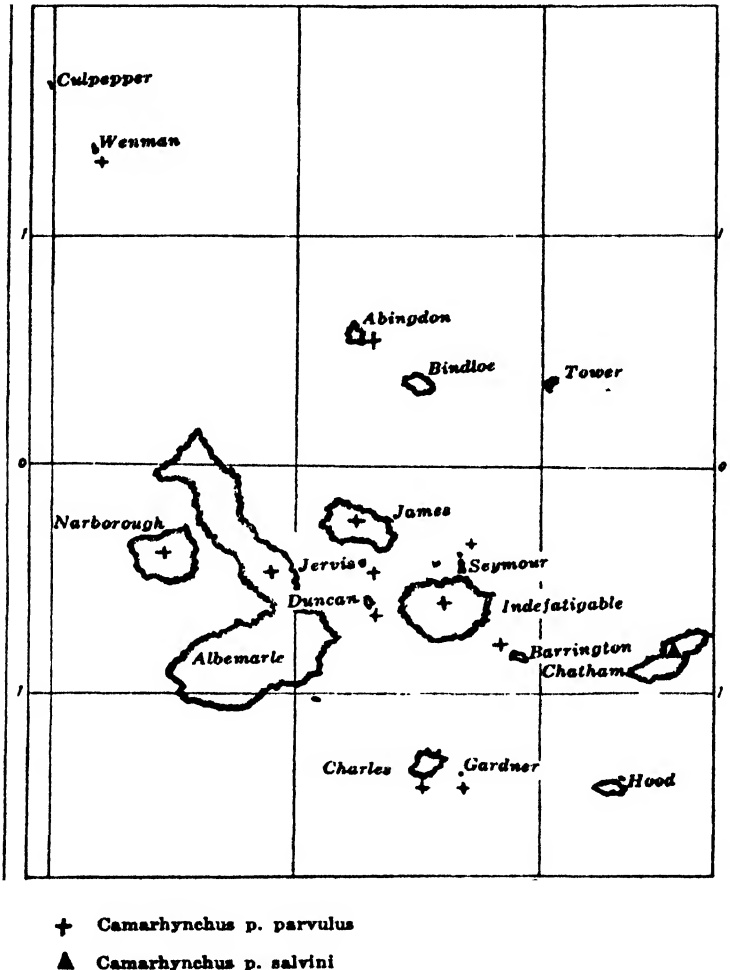


Fig. 50. Map showing distribution of the subspecies of *Camarhynchus parvulus*. Symbols indicate islands where recorded.

(Gould), with the type locality James Island. As regards the specific identity of Gould's male bird it is of interest to read Sharpe's (*loc. cit.*) brief description and comments.

DESCRIPTION.—Similar to *psittacula*, *habeli*, *affinis* and *pauper* in markings and color but much smaller. Shape of bill as in *pauper* but smaller. **Juvenal.**—Young birds at hand are streaked below (no black-headed individuals, as there are in the *pauper* series) and, as in *pauper*, some of these are molting into a plumage that is plain buffy yellow, unmarked, below.

HABITAT.—Wenman, Abingdon, James, Jervis, Seymour, Indefatigable, Duncan, Albemarle, Cowley, Narborough, Barrington, Charles, Gardner-near-Charles.

A total of 277 specimens was collected (nos. 7715-7737, 7739-7820, 7822-7847, 7849-7992, 8349). Specimens were collected on Wenman Island September 24; Abingdon: September 19, 20; James: August and January; Duncan: December 7; Indefatigable: January, July, October, November; Albemarle: March, April, August, November; Charles: February, March, May, June, October.

There are black-headed males in the series representing every month except July, September, and December. The one November example has the bill mostly black; all those collected during January, February, March and April have the bill entirely black; during May, June, and August the bill is mostly light colored, though some are intermediate and one August bird has a jet black bill; bills of October birds are mostly light colored, though some are intermediate. Males that are not black-headed (that is, in exactly the same plumage as females), and the adult females, exhibit the same seasonal change in color of bill.

According to Gifford (1919, p. 250) the breeding season (that is, from the beginning of mating until the period when most of the young are fledged) lasts from early November until early May, so it may be seen that bill color in adult birds practically coincides, the black with the breeding season, light color with the non-breeding season. There are long series of specimens at hand taken from May to November, some of which are obviously young of the year, and many more of which may belong in that category, all with light colored bills. Data given by Rothschild & Hartert (1899, p. 169) regarding bill color in this species, so far as it goes, corroborate my own statements.

The proportion of black-headed males seems to be about the same on each of the four islands that are adequately represented in our collection. On Charles, of the total of 77 apparently mature

males, 33 are black-headed; on Albemarle, 11 out of 26; on Indefatigable, 3 out of 12; on James, 5 out of 10.

I can not trace in our series the nicely graded and defined series of plumages that are described by Ridgway (1901, p. 484) as pertaining to "adult male", "immature male", "young male", "adult female", and "young female". All of the birds at hand that are in juvenal plumage are heavily streaked with dusky below. The few specimens showing the post-juvenal molt are losing the streaks and assuming a plumage that is uniformly buffy yellow on the under parts. Such a plumage, however, does not always follow the post-juvenal molt, for there are breeding birds, both male and female, with black bill, that are streaked on breast and flanks, and are exactly alike. There are more males that are streaked below and more females that are immaculate.

Under *salvini* I am stating my reasons for considering *parvulus* and *salvini* as only subspecifically different. In this connection allusion should be made to six specimens, including one in juvenal plumage, from Albemarle Island (nos. 7867, 7875, 7883, 7909, 7969, 7988), which I have hesitatingly referred to *parvulus*. These birds are appreciably larger than the mode of that form, being about midway in size between *parvulus* and *affinis*. The young bird, even, has a larger bill than black-headed males of *parvulus*.

There are slight average color differences apparent between series from different islands. James Island birds are grayish above, and uniformly so throughout the series. Albemarle and Indefatigable birds are appreciably darker, more greenish, on the back. The Charles Island series (by far the most extensive) exhibits both types of coloration. These differences are most apparent in the adult males.

93. *Camarhynchus parvulus salvini* Ridgway

Camarhynchus salvini Ridgway, 1894, p. 364 (orig. descr.; Chatham Island); 1897, p. 561; 1901, p. 486.

Geospiza salvini Rothschild & Hartert, 1899, p. 169; 1902, p. 402.

Geospiza prosthemelas salvini Snodgrass & Heller, 1904, p. 287.

Camarhynchus prosthemelas Sundevall, 1871, p. 125, part (Chatham Id.).—Ridgway, 1890, p. 110, part (Chatham Id.).—Gifford, 1919, p. 250, part.

CAMARHYNCHUS SALVINI Ridgway

Type.—United States National Museum, no. 125977; ♂ (in female plumage); Chatham Island; March 30, 1891; C. H. Townsend.

DESCRIPTION.—Similar to *C. p. parvulus*, from which it differs in slightly larger size, in having the plumage throughout strongly tinged with yellowish, and in that the mature male rarely has any black upon head or throat and then only to a limited extent.

HABITAT.—Chatham Island.

One hundred and twenty-six specimens collected, taken during September, October, January, February, and July (nos. 7993-8041, 8043-8061, 8063-8120). Of 69 males just five show more or less black on head and throat, in no case as much as in the maximum reached by *parvulus* on other islands. Ridgway (1901, p. 486) describes the adult male of *salvini* as "apparently without any black on head, neck, or chest." Rothschild & Hartert (1899, p. 169) comment upon the fact that up to that time, out of 74 skins that had been examined by ornithologists, not one black-headed male had been seen. Snodgrass & Heller (1904, p. 287) found one black-headed bird among the five adult males that they collected. Obviously in this form the black-headed condition can not be regarded as normal to all fully adult males. It is a phase of plumage that occurs in a very small percentage of the population, smaller perhaps than is shown by the figures of specimens collected, for black-headed birds would be conspicuous objects to any collector and would certainly be pursued as another bird might not be.

Variation in bill color, dark or light, is as follows. September: out of 9 specimens, one has a dusky bill. October: 43 specimens, 10 with dusky or black bill. January: 37 specimens, 26 with black bill. February: 26 specimens, 22 with black bill. July: 11 specimens, none with black bill. Of the five males with more or less black on head and throat, one, September 10, has a dusky bill; one, October 17, has a dusky bill; one, January 26, has a black bill; one each on July 6 and 7, have the bill light colored.

Salvini, as exemplified in our series, is a recognizable form, closely similar to *C. parvulus parvulus* but differing, except for the detail of the occasional black head, just as described by Ridgway (*loc. cit.*): "larger, more strongly tinged with buffy yellow and more extensively streaked beneath, the adult male apparently without any black on head, neck, or chest." The difference in size between *parvulus* and *salvini* is more evident in the series of prepared specimens than would be expected from the relatively slight differences shown in the table of comparative measure-

ments. *Salvini* is obviously a larger, bulkier bird. Size differences between the two are bridged by individual variants, and considering this variation and the kind and degree of difference between the two, it seems best to consider them as only sub-specifically separated.

**SPECIMENS OF THE *Camarhynchus parvulus* GROUP IN THE ACADEMY COLLECTION AND
(FIGURES IN PARENTHESIS) IN THE STANFORD UNIVERSITY COLLECTION**

Name	Island	Male (black- headed)	Male (non-black- headed)	Female	Young	Sex undetermined
<i>Camarhynchus p. parvulus</i>	Wenman			2		
<i>Camarhynchus p. parvulus</i>	Abingdon		1	1		
<i>Camarhynchus p. parvulus</i>	James	5 (4)	5 (1)	4 (3)	(5)	2 (1)
<i>Camarhynchus p. parvulus</i>	Seymour			1		
<i>Camarhynchus p. parvulus</i>	Indefatigable	3	10	14		
<i>Camarhynchus p. parvulus</i>	Duncan			1	(1)	
<i>Camarhynchus p. parvulus</i>	Albemarle	12 (7)	16 (1)	27 (1)	2 (1)	2 (1)
<i>Camarhynchus p. parvulus</i>	Narborough			(7)		
<i>Camarhynchus p. parvulus</i>	Charles	36 (2)	41 (1)	58 (3)	8	23
<i>Camarhynchus p. parvulus</i>	Gardner- near-Charles					1
<i>Camarhynchus p. parvulus</i>	Champion					2
<i>Camarhynchus p. salvini</i>	Chatham	5 (1)	63 (4)	39 (2)		9

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM) OF THE
SUBSPECIES OF *Camarhynchus parvulus*

MALES

Number of specimens	Name	Island	Wing	Tail	Culmen	Gonyx	Depth of bill at base	Width of mandible at base	Tarsus	Middle toe with claw
5	<i>Camarhynchus p. parvulus</i>	James	83.4 (82.0-85.0)	37.5 (36.5-38.5)	9.1 (8.5- 9.5)	5.3 (5.0-5.5)	6.7 (6.5-7.2)	5.7 (5.0-6.0)	20.3 (20.0-21.0)	15.7 (15.5-16.0)
10	<i>Camarhynchus p. parvulus</i>	Albemarle	82.0 (61.0-84.2)	37.8 (36.5-40.0)	10.0 (9.0-10.5)	5.5 (5.5-6.0)	7.2 (7.0-7.5)	5.8 (5.5-6.0)	21.2 (20.0-22.0)	15.0 (15.0-16.5)
10	<i>Camarhynchus p. parvulus</i>	Indefatigable	82.3 (61.0-84.0)	38.4 (36.0-40.0)	9.7 (9.0-10.5)	5.9 (5.5-6.0)	7.1 (7.0-7.2)	6.0 (6.5-6.2)	21.0 (20.5-22.0)	16.0 (15.5-16.5)
10	<i>Camarhynchus p. parvulus</i>	Charles	83.9 (61.0-86.0)	40.3 (38.0-42.0)	9.8 (9.5-10.0)	5.5 (5.2-6.0)	7.5 (7.0-8.0)	6.5 (6.0-6.5)	20.5 (19.0-21.0)	16.3 (16.0-16.8)
10	<i>Camarhynchus p. salvini</i>	Chatham	85.1 (63.0-87.0)	40.5 (38.5-43.0)	10.9 (10.2-11.5)	6.1 (6.0-7.0)	7.8 (7.2-8.5)	6.3 (6.2-6.5)	21.8 (21.0-23.0)	16.5 (16.0-17.0)

FEMALES

6	<i>Camarhynchus p. parvulus</i>	James	88.9 (55.0-61.5)	35.6 (34.2-37.0)	10.3 (10.2-10.5)	5.5 (5.0-6.0)	6.9 (6.5-7.2)	5.8 (5.2-6.2)	19.5 (19.0-20.0)	15.3 (15.0-15.5)
10	<i>Camarhynchus p. parvulus</i>	Albemarle	60.2 (57.2-65.0)	37.1 (34.5-42.5)	10.2 (9.2-11.0)	5.9 (5.5-6.2)	7.3 (6.5-7.8)	6.1 (5.5-6.5)	20.3 (19.5-21.2)	16.2 (15.5-16.5)
10	<i>Camarhynchus p. parvulus</i>	Indefatigable	60.5 (58.2-62.5)	36.8 (35.5-38.3)	10.0 (9.0-10.5)	5.7 (5.0-6.2)	7.0 (6.5-7.5)	5.9 (5.5-6.2)	20.2 (19.0-21.0)	16.0 (15.5-16.8)
10	<i>Camarhynchus p. parvulus</i>	Charles	59.7 (58.2-61.5)	36.9 (35.2-38.5)	10.1 (9.2-10.8)	5.6 (5.2-6.0)	7.1 (6.8-7.5)	6.0 (5.8-6.2)	20.0 (19.2-21.2)	15.9 (15.2-16.2)
10	<i>Camarhynchus p. salvini</i>	Chatham	61.4 (60.0-63.5)	37.9 (35.0-39.5)	10.5 (9.5-11.0)	6.1 (5.8-6.2)	7.3 (6.8-7.8)	6.2 (6.0-6.5)	20.6 (19.5-22.0)	15.8 (15.0-16.5)

94. *Camarhynchus aureus* Swarth

Camarhynchus aureus Swarth, 1929, p. 34.

"*Type*.—Male adult, no. 8121, Mus. Calif. Acad. Sci., collected by E. W. Gifford (orig. no. 1944), January 25, 1906, on Chatham Island, Galapagos Archipelago.

"*Characters*.—Generally similar to *Camarhynchus conjunctus* but with slightly heavier bill and more uniform coloration.

"*Description of type and only known specimen*.—In rather worn plumage. Upper parts faded, but evidently originally dull olive green. Remiges and rectrices dusky, narrowly edged with olivaceous. Closed wings, including coverts, uniform with back. There are faint indications of light tips to the greater and middle wing coverts, and in fresh plumage there may have been discernible wing bars. Below, from bill to and including lower tail coverts, almost uniformly pale yellow, broken only by a slightly mottled appearance on the breast, where the blackish bases of the feathers show through, and with sides of breast and flanks slightly darker. The yellow of the under surface spreads over the sides of neck and face, over cheeks and ear coverts, to meet a broad yellow superciliary line that extends from bill and forehead back to a point well behind the eye. Bill blackish, with edges of upper and tip of lower mandible slightly paler. Feet and legs blackish. . . .

"These two new forms from Charles and Chatham islands, *conjunctus* and *aureus*, appear to be closely related, and it might be that adequate series of the two would show plumage variation that would bring them even closer together than is indicated by the scanty material now available. The differences apparent in the skins at hand, however, especially as two rather widely separated islands are represented, are such as to justify the present separation of the two forms.

"In these two puzzling species (*conjunctus* and *aureus*) resemblance to *Certhidea* lies in general size and form and in certain peculiarities of marking. Resemblance to *Camarhynchus* appears in the more finch-like bill and in general coloration, which in *conjunctus* and *aureus* is very close to the unstreaked 'immature' plumage of *Camarhynchus parvulus*. There may be significance in the fact that *C. parvulus salvini* from Chatham Island is strongly tinged with yellow, just as is the one specimen of *C. aureus* from that island.

"It is a debatable point as to whether *conjunctus* and *aureus*

should not be segregated together in a separate genus. Such a genus would have to be based upon the combination of certain characters, some of which in other species occur in *Camarhynchus*, some in *Certhidea*, and the genera already described in the Geospizidæ are so nearly arbitrary in their nature that it seems to me undesirable to add another genus of uncertain definition" Swarth (1929, p. 34-35).

95. *Camarhynchus conjunctus* Swarth

Camarhynchus conjunctus Swarth, 1929, p. 33.

"*Type*.—Male adult, no. 7713, Mus. Calif. Acad. Sci., collected by R. H. Beck, February 28, 1906, on Charles Island, Galapagos Archipelago.

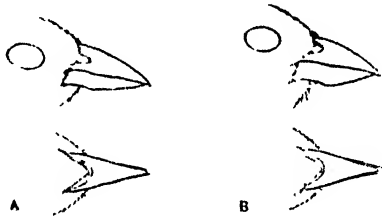


Fig. 51. a, *Camarhynchus conjunctus*, male (no. 7713, type), Charles; b, *Camarhynchus aureus*, male (no. 8121, type), Chatham. Natural size.

"*Characters*.—Intermediate in certain outstanding features between *Camarhynchus* and *Certhidea*. In measurements and in bulk lies between the maximum reached in *Certhidea* and the minimum in other species of *Camarhynchus*. The bill in particular is intermediate in shape and size between those of typical *Certhidea* and typical *Camarhynchus*.

"*Description of type*.—In fresh, unworn plumage. Upper parts generally dull olive green, feathers of pileum with dusky centers, giving a blackish appearance to top of head. Sides of head like back; eyelids and faint superciliary line pale yellowish. Remiges and rectrices dusky, edged with olivaceous. Greater and middle wing coverts like back, narrowly edged with yellowish, producing two poorly defined wing bars. Below greenish yellow, paler than back. Sides of breast and flanks, and lower tail coverts, tinged with brownish; middle of belly pale yellowish. Chin and throat

indistinctly marked with tawny of the same shade as is characteristic of the throat patch in species of *Certhidea*. Feathers of throat and upper breast black-centered, producing a streaked appearance, the general effect of which is of poorly defined black lines surrounding a rather nebulous tawny throat patch. 'Bill black; legs dark brown; testes large' (collector's notation on label).

"A second specimen, also an adult male, collected by Beck on the same day, is in rather more worn plumage. Color of upper parts is about as in the type, but below it is paler colored, more whitish and with less of the greenish hue. The black streaks on the breast are obscurely indicated, and the tawny on the throat is washed out and but faintly discernible. The rufous is more widespread than on the type, though, spreading to the sides of the head and invading even the superciliary line. 'Bill black, iris dark brown; legs dark brown; testes large'" (Swarth, 1929, p. 33).

Gifford's field note book, under date of February 28, 1906, contains the following entry pertaining to these birds, which, it is interesting to note, he designated "*Geocerthidea*": "Berk took two birds resembling the one I took on Indefatigable on January 18 [= *Cactospiza giffordi*]. They had similar bills, intermediate between *Cactospiza* and *Certhidea*, and had the reddish-brown on the throat, as my bird did, and as is common to *Certhidea*. Their sexual organs were well-developed. These birds were considerably smaller than the Indefatigable kind." Elsewhere in the note book there is an entry to the effect that they were found above 1000 feet altitude.

MEASUREMENTS IN MILLIMETERS OF *Camarhynchus aureus* AND *G. conjunctus*

C.A.S. No.	Sex Age	Species	Locality	Date	Wing	Tail	Culmen	Gonys	Depth of bill at base	Width of bill at base	Tarsus	Middle toe with claw
8121 ¹	♂ ad.	<i>Camarhynchus aureus</i>	Chatham Id.	Jan. 25, 1906	58.0	35.0	9.0	6.0	5.5	5.5	21.0	16.5
7713 ¹	♂ ad.	<i>Camarhynchus conjunctus</i>	Charles Id.	Feb. 28, 1906	59.0	40.0	10.0	6.2	5.2	5.0	20.0	15.0
7714	♂ ad.	<i>Camarhynchus conjunctus</i>	Charles Id.	Feb. 28, 1906	53.2	38.5	9.5	6.0	5.8	5.0	21.0	17.0

¹ Type

Genus CACTOSPIZA Ridgway

Cactospiza Ridgway, Proc. U. S. Nat. Mus., XIX, no. 1116, March 15, 1897, p. 546. (Type, *Cactornis pallidus* Sclater & Salvin.)

Medium sized Geospizidæ (wing 64-77 mm.); coloration plain gray, olivaceous or dusky, with no conspicuous markings, one species with faint chestnut markings on throat; bill relatively slender, "tanager-like," culmen convex, gonys slightly convex; relative length of "middle toe with claw" to tarsus about 8.5 : 10.

Cactospiza was proposed by Ridgway (*loc. cit.*) as a subgenus under *Camarhynchus*, but was in a later paper (1901, p. 476) sunk into the synonymy of the latter name. Rothschild & Hartert (1899, p. 152) and Snodgrass & Heller (1904, p. 273) object to the generic segregation of this group of species, though the last mentioned authors use the name *Cactospiza* as a subgenus. It is partly on the characters of the birds in question that those several authors merge all of the Galapagos "finches" into the one genus *Geospiza*, the assumption being that *Cactaspiza* forms a link between *Geospiza* and *Camarhynchus*. The resemblance lies in the fact that both *G. scandens* and *C. pallida* are slender-billed birds, but I am convinced that this is no more than a fortuitous resemblance, due to the parallel development of rather remote strains. Shape of bill in the two groups differs appreciably in detail, *pallida* with a slightly convex gonys, and the whole bill rather tanager-like in outline, *scandens* with the gonys straight (as in other species of *Geospiza*) and the shape of the bill suggestive of the Icteridæ. In *pallida* and related forms coloration is alike in both sexes, and no black markings are normally present, while in *scandens* and allied species there is found the utmost development of black coloration, with the females nearly as black as the males, as is not the case in most species of *Geospiza*.

96. *Cactospiza pallida* (Sclater & Salvin)

Cactornis pallida Sclater & Salvin, 1870, pp. 323, 327 (orig. descr.; Indefatigable Id.).—Salvin, 1876, p. 487, fig.—Sharpe, 1888, p. 20.—(?) Ridgway, 1890, p. 109 (James Id.).

Camarhynchus pallidus Ridgway, 1897, p. 565; 1901, p. 487.—Gifford, 1919, p. 253.

Geospiza pallida Rothschild & Hartert, 1899, p. 165; 1902, p. 399, part.—Snodgrass & Heller, 1904, p. 277, part.

C[actornis]. hypoleuca Ridgway, 1890, p. 109, in text (orig. descr.; James Id.).

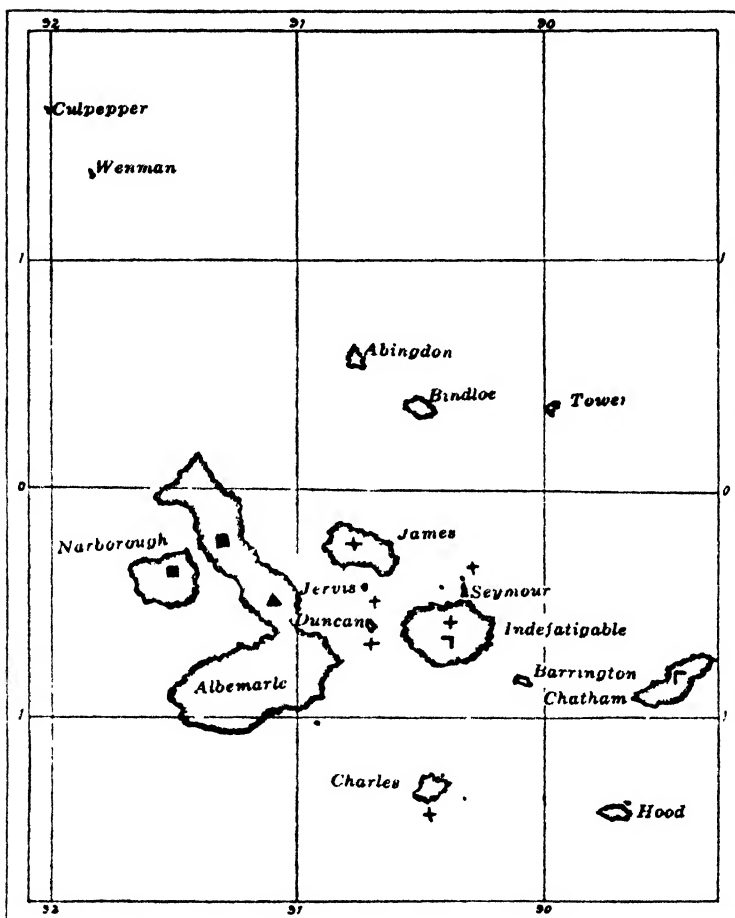
+ *Cactospiza pallida pallida*┐ *Cactospiza pallida striatipecta*▲ *Cactospiza pallida producta*└ *Cactospiza giffordi*■ *Cactospiza hellobates*

Fig. 52. Map showing distribution of the species and sub-species of *Cactospiza*. Symbols indicate islands where recorded.

CACTORNIS PALLIDA Sclater & Salvin

Cotype.—British Museum, no. 85.12.14.562; ♂; Indefatigable Island; September 9, 1868; Dr. A. Habel.

Cotype.—British Museum (no catalogue number); ♀; Indefatigable Island; September 14, 1868; Dr. A. Habel.

No. 85.12.14.562 indicated by Sharpe (1888, p. 21) as "type of species" and now bearing a red "type label."

CACTORNIS HYPOLEUCA Ridgway

Type.—United States National Museum, no. 115997; ♂; James Island; April 11 (1888); U. S. Fish Commission, Voyage of Albatross, 1887-88.

DESCRIPTION.—Sexes alike; bill slender, depth at base less than distance from nostril to tip of maxilla. Top of head dirty gray; back olivaceous brown, dorsum with faintly indicated darker streaks, rump immaculate; remiges and rectrices dusky, narrowly edged with olivaceous on outer edges; wing coverts dusky, broadly edged with olivaceous; lores, and a poorly defined area about the eye, dirty whitish; cheeks and ear coverts, mixed whitish and olivaceous; chin and throat almost pure white; rest of ventral surface of body whitish, strongly tinged with yellowish or buffy; under tail coverts buffy.

HABITAT.—James, Jervis, Seymour, Indefatigable, Duncan, and Charles islands.

*Cactospiza pallida** (including the three forms, *pallida*, *producta*, and *striatipecta*) is represented in the Academy collection by 163 specimens. I have included under *C. pallida pallida* the specimens from James, Jervis, Seymour, Indefatigable, Duncan, and Charles islands, though in at least some of these series there are minor features apparent that might serve as bases for nomenclatural distinctions. *Cactornis pallida* Sclater & Salvin was based upon specimens from Indefatigable. We have fairly adequate series from James, Indefatigable, Duncan, and Chatham, and abundant material from Albemarle.

Birds from Chatham and Albemarle are sufficiently differentiated to justify the use of separate names, as indicated beyond. Birds from Indefatigable are characterized by a rather strong tinge of olive yellow that suffuses the entire plumage, and by absence of all but the faintest indications of striation below. James Island birds are on the average appreciably more gray, a trifle more streaked on the breast, and have a slightly longer wing. Ridgway (1890, p. 109, in text) applied the name *hypoleuca* to the James Island form on the basis of just these differences. On

*The Academy series of the three subspecies of *C. pallida* and *C. heliobates* are catalogued together, mixed, under the inclusive numbers 7523-7588, 7590-7712.

one adult male in the Stanford University collection (no. 4591, James Island) the breast streaks are developed so as to form a black blotch on the lower throat and upper breast. Duncan Island birds are tinged with olive yellow, as are the Indefatigable birds, but are paler colored. These are average differences that are appreciable in assembled series from the several islands, but they are not present to a distinguishable degree in all individuals. The few specimens from Charles and Jervis islands are not peculiar in any way, but it would require larger series to bring out the sort of variation that appears in our array of skins from the other islands.

The bill is dark or light colored, or of an intermediate hue, according to season, December and January birds being mostly

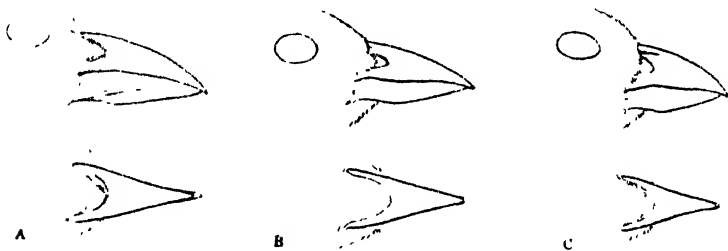


Fig. 53. *Cactospiza pallida*, males: a, *C. p. pallida* (no. 7619), James; b, *C. p. producta* (no. 7697), Albemarle; c, *C. p. striatipecta* (no. 7681), Chatham. Natural size.

black-billed, July and August specimens yellow-billed. Specimens from James Island were collected during August, December, and January; from Jervis, December 20; from Indefatigable, July, October, November; from Seymour, July 26; from Duncan, August and December; from Charles, October 11. None of these show any sign of molt.

97. *Cactospiza pallida producta* (Ridgway)

Camarhynchus productus Ridgway, 1894, p. 364 (orig. descr.; Albemarle Id.); 1897, p. 566.—Hartert, 1919, p. 153 (particulars of type specimen, in Rothschild Museum).

Camarhynchus pallidus Ridgway, 1901, p. 487, part.

Geospiza pallida Rothschild & Hartert, 1899, p. 165, part.—Snodgrass & Heller, 1904, p. 277, part.

CAMARHYNCHUS PRODUCTUS Ridgway

Type.—Rothschild Museum; ♂ ; Albemarle Island; July 31, 1891; Dr. G. Baur; orig. no. 404.

DESCRIPTION.—Exactly like *C. pallida pallida* in coloration but with slightly smaller bill.

HABITAT.—Albemarle and (presumably) Narborough islands.

The Academy series includes 118 skins from Albemarle Island. Gifford (1919, p. 254) reports *pallida* from Narborough, but no specimens were collected there and so far as I know there are no skins extant from that island. It is a fair assumption that the form on Narborough would be the same as on Albemarle. *Producta* was described by Ridgway (1894, p. 364) as differing from *pallida* in being smaller (the bill especially) and deeper colored. Ridgway later (1901, p. 489) tentatively placed *producta* as a synonym of *pallida*, and no other writer has recognized the form. It is admittedly a slightly differentiated race, but may be permitted to stand on the basis of the small bill, which is an appreciable and fairly constant character (see table of measurements). The supposed color difference is non-existent.

Our large series of specimens suffices to show the essential features of this bird. The sexes are alike; I can not discern a particle of color difference between them. Compared with other forms of *pallida*, *producta* averages rather pale colored, much like the birds from Duncan, but the range of variation in the series includes a few specimens that are darker even than typical *pallida*. There is an almost total absence of striation on the breast. In only a few cases is it indicated, and then but slightly. There is one specimen entirely in juvenal plumage and others in the post-juvenal molt. The young bird is heavily streaked below and is darker colored, more blackish than in subsequent stages. Molting juveniles are assuming a buffy yellow plumage that is indistinguishable from the adult. The post-juvenal molt, as well as the annual molt of the adults, was taking place during March and April. In the young bird the bill is light colored. In later stages black bills predominate in specimens collected from early November to early March, and there are one or two black-billed specimens collected on May 1. A large part of the series of *producta* was collected in August, and of these the birds taken early in the month have yellowish bills, while some of those taken late in the month have the bill black or beginning to turn dusky.

98. *Cactospiza pallida striatipecta*, new subspecies

Type.—Male adult, no. 7637, Mus. Calif. Acad. Sci., Chatham Island, Galapagos Archipelago; January 29, 1906; collected by R. H. Beck.

CHARACTERS.—A slightly differentiated form of *Cactospiza pallida*, distinguished by characters of color and structure. Compared with *pallida* and *producta* it is more conspicuously streaked below, and the bill is shorter and heavier.

HABITAT.—Chatham Island.

The Academy series consists of ten specimens, six adult males (one collected September 10, one January 26, four January 29), two adult females (January 29), one apparently immature female (September 8), and one male in juvenal plumage (February 23).

Some specimens of *pallida* from James Island show more ventral streaking than some individuals of *striatipecta*, but the streaked condition is more general and the streaks more sharply defined in the latter series. Just one of the ten specimens is unstreaked below. The best character of the Chatham Island form, however, lies in the bill, which is shorter and heavier than in the other subspecies of *pallida*. Of the seven January specimens, four have the bill black, in three it is dusky. In the September taken male it is dusky; in the September taken female (possibly an immature bird) it is yellowish. In the juvenile it is yellowish. The young bird is lightly streaked below, on a ground that is whitish with a faint yellowish suffusion. It is less heavily streaked than young of *pallida*, in which the adult is immaculate.

The Academy expedition was the first to obtain a series from Chatham Island. Gifford, in his published field notes upon this collection (1919, p. 254) remarks that: "On Chatham they were taken in the humid zone just below the sugar plantations and in the region intermediate between the humid and arid." The only previous allusion to the occurrence of *pallida* on Chatham is the following statement by Rothschild & Hartert (1899, p. 166): "There is also a skin taken out of a jar of spirits said to contain Chatham Island birds only, collected by Messrs. Baur & Adams, but we are inclined to believe that this specimen has by mistake found its way into the Chatham jar." I have seen this bird, which seems without doubt to be of the Chatham Island subspecies.

99. *Cactospiza giffordi* Swarth

Cactospiza giffordi Swarth, 1929, p. 32.

"*Type*.—Male adult, no. 7522, Mus. Calif. Acad. Sci., collected by E. W. Gifford (orig. no. 1900), January 18, 1906, on Indefatigable Island, Galapagos Archipelago.

"*Characters*.—Evidently nearly related to the *pallida-heliobates* group, but much smaller and with more slender bill than any other described form in that group.

"*Description of type and only known specimen*.—In rather worn plumage. Above brownish, about as in the darker examples of *pallida*, with an olivaceous tinge. Top of head slightly darker than dorsum. A poorly defined superciliary stripe of yellowish from nostril to posterior corner of eye. Sides of head dirty brownish; a poorly defined grayish spot on lower eyelid. Remiges and rectrices dusky, with narrow edgings of greenish olive; under

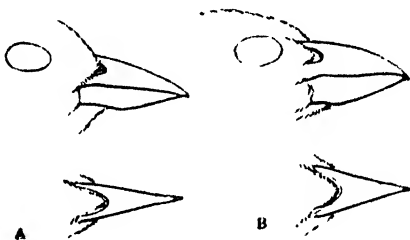


Fig. 54. a, *Cactospiza giffordi*, male (no. 7522, type), Indefatigable; b, *Cactospiza heliobates*, male (no. 4186, coll. Stanford Univ., type), Albemarle. Natural size.

wing coverts strongly tinged with yellow. Under parts of body and lower tail coverts plain, unstreaked; whitish, strongly tinged with yellow. Sides of breast and flanks grayish brown. On chin and throat irregular flecks of the tawny color characteristic of the throat color in species of *Certhidea*. Bill black; feet dusky "Testicles very large" (collector's notation on label)" (Swarth, 1929, p. 32).

"I obtained one bird at about 350 feet elevation which seemed to be intermediate between *Certhidea* and *Geospiza pallida*. It was feeding like a *Geospiza pallida* on a branch of a tree" (E. W. Gifford's manuscript field note book).

100. *Cactospiza heliobates* (Snodgrass & Heller)

Geospiza heliobates Snodgrass & Heller, 1901, p. 96 (orig. descr.; Tagus Cove, Albemarle Island); 1904, p. 279.—Rothschild & Hartert, 1902, p. 400.

GEOSPIZA HELIOBATES Snodgrass & Heller

Type.—Leland Stanford Junior University, no. 4186; ♂ ad.; Tagus Cove, Albemarle Island; January (wrongly given as June in the original description) 24, 1899; R. E. Snodgrass and E. Heller (Hopkins-Stanford Galapagos Expedition); orig. no. 123.

Description of the type.—Above dark brown with an olive tinge on the rump, all of the feathers of the dorsum with narrow pale olive-grayish edgings. Wing and tail feathers lighter, more smoky brown. Lores, sides of head and underparts dirty buffy-gray, brownish-buff on the sides and flanks. Lores spotted with brown. Feathers of the breast and sides with dark brown central areas forming spots of the same color. Tips of the greater and middle wing-coverts rather indistinctly brownish-rufous, forming two inconspicuous cross bands. Under wing-coverts grayish; under tail coverts brownish-buff with pale grayish edgings. Under surface of wing and tail feathers grayish brown. Bill black. Feet dark brown" (Snodgrass & Heller, 1901, p. 96).

Adult female.—Closely similar to the male but on the average with less indication of ventral streaking. In fresh plumage almost immaculate below.

Juvenal.—Darker than the adult, slaty black in general appearance, with faintly indicated olivaceous edgings on back, wings and tail. Head and chest almost solidly blackish; rest of under parts, except mid-belly, heavily streaked with blackish.

HABITAT.—Albemarle and Narborough islands.

Represented in the Academy collection by twenty-six specimens, including thirteen adult males, eight adult females, and five males in juvenal plumage. One was collected at "S. Albemarle," November 1. The others were all taken on North Albemarle, at the two closely adjacent localities, Tagus Cove and Turtle Point, during March and April. It is a question as to what is the proper way to treat this form nomenclaturally. The relationships of *heliobates* are obviously with *pallida*, and the nature and amount of differences that differentiate the two are such as to argue for sub-

specific treatment. However, as *heliobates* and a form of *pallida* (*producta*) occur on the same island I have regarded them as distinct species.

Heliobates was first described as resembling *pallida* in color but having a smaller bill; subsequently Rothschild & Hartert (1902, p. 400) pointed out the fact that in *heliobates* the breast is striped, as ordinarily it is not in *pallida*. In addition, the general color is different, as between *heliobates* and any form of *pallida*, a difference that is readily appreciable in fresh plumage but that tends to become obscured when the feathers are worn.

Cactospiza pallida is a yellowish colored bird, *heliobates* a slaty colored one. The general color of *heliobates* above is dark, almost uniformly blackish. The feathers on the dorsum show but a faint indication of olivaceous edges, the dark centers producing a correspondingly faintly streaked effect. The under parts are whitish, the feathers on breast and sides conspicuously streaked, with dark centers and whitish edges. As the plumage becomes worn the ventral streaks are more and more conspicuous, sometimes with the effect of an almost solidly black breast. The juvenal plumage is as dark as in the adult, and even more heavily streaked below. The young birds have a distinctly black headed appearance. November, March, and April adults at hand are black-billed, with one exception (March 30). in which the lower mandible is light colored. In juveniles the lower mandible is yellowish, the upper slightly dusky. Three specimens collected one on March 30, two on April 18, are apparently young birds just finished with the post-juvenal molt, and in these the bill is light colored.

SPECIMENS OF THE SPECIES AND SUBSPECIES OF *Cactospiza* IN THE ACADEMY COLLECTION
AND (FIGURES IN PARENTHESES) IN THE STANFORD UNIVERSITY COLLECTION

Name	Island	Male	Female	Young	Sex undetermined
<i>Cactospiza p. pallida</i>	James	8(1)	5		
<i>Cactospiza p. pallida</i>	Jervis	2			
<i>Cactospiza p. pallida</i>	Seymour	1			
<i>Cactospiza p. pallida</i>	Indefatigable	4	7		
<i>Cactospiza p. pallida</i>	Duncan	6	1		
<i>Cactospiza p. pallida</i>	Charles	1			
<i>Cactospiza p. producta</i>	Albemarle	63	36	9	10(1)
<i>Cactospiza p. striatipecta</i>	Chatham	6	3	1	
<i>Cactospiza heliobates</i>	Albemarle	11(14)	7(12)	8(4)	
<i>Cactospiza heliobates</i>	Narborough	(2)	(1)	(4)	(1)
<i>Cactospiza giffordi</i>	Indefatigable	1			

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM) OF SPECIES AND
SUBSPECIES OF *Cactospiza*

MALES

Number of specimens	Name	Island	Wing	Tail	Culmen	Gonyx	Depth of bill at base	Width of mandible at base	Tarsus	Middle toe with claw
8	<i>Cactospiza p. pallida</i>	James	75.0 (73.5-77.0)	46.0 (43.0-48.0)	16.7 (15.0-17.2)	9.6 (9.0-10.0)	9.0 (8.5-9.5)	7.2 (7.0-7.5)	24.3 (24.0-25.0)	20.2 (19.0-21.0)
2	<i>Cactospiza p. pallida</i>	Jervis	70.0-71.0	42.0-43.5	16.0-16.0	9.0- 9.5	8.0-8.2	7.0-7.0	24.0-24.0	20.5-21.0
5	<i>Cactospiza p. pallida</i>	Indefatigable	71.0 (71.0-72.5)	44.2 (42.0-46.0)	16.3 (16.0-17.0)	9.3 (9.0-10.0)	8.8 (8.5-9.0)	7.1 (7.0-7.2)	23.5 (23.0-24.5)	19.7 (17.5-21.0)
6	<i>Cactospiza p. pallida</i>	Duncan	71.0 (70.0-72.5)	42.6 (40.0-45.5)	15.4 (15.0-16.2)	9.2 (8.5-10.0)	8.6 (8.3-9.0)	7.1 (7.0-7.2)	23.6 (23.0-24.0)	20.1 (19.0-21.0)
7	<i>Cactospiza p. pallida</i>	Charles	69.5	43.2	16.5	10.0	8.2	7.0	24.2	19.0
10	<i>Cactospiza p. producta</i>	Albemarle	69.9 (67.5-72.0)	43.3 (41.0-45.2)	14.9 (14.0-15.5)	8.4 (8.0- 8.8)	7.8 (7.0-8.5)	6.8 (6.2-7.0)	23.4 (23.0-24.0)	18.8 (17.0-20.0)
6	<i>Cactospiza p. striatipennis</i>	Chatham	70.3 (69.0-71.5)	44.1 (42.0-47.0)	13.9 (13.5-14.2)	7.9 (7.5- 8.0)	8.3 (8.0-8.5)	6.9 (6.5-7.2)	23.1 (22.5-24.0)	19.8 (17.5-21.0)
10	<i>Cactospiza hirsutissima</i>	Albemarle	71.5 (70.0-73.5)	43.4 (42.2-45.2)	13.8 (12.2-14.5)	7.8 (7.5- 8.0)	7.6 (7.2-8.0)	6.7 (6.2-7.0)	22.0 (21.0-23.0)	19.1 (18.0-20.0)
1	<i>Cactospiza giffordii</i>	Indefatigable	51.0	41.5	13.5	8.2	6.5	5.0	22.5	17.0

FEMALES

5	<i>Cactospiza p. pallida</i>	James	70.3 (69.0-72.0)	43.3 (41.5-45.0)	16.4 (16.0-17.0)	9.1 (9.0- 9.2)	8.7 (8.5-9.2)	7.5 (7.2-8.0)	23.6 (23.0-24.0)	20.6 (20.0-21.5)
7	<i>Cactospiza p. pallida</i>	Indefatigable	64.9 (67.0-70.0)	41.0 (37.0-43.0)	15.8 (15.0-17.0)	9.2 (9.0-10.0)	8.5 (8.3-9.0)	7.0 (6.8-7.2)	23.1 (22.0-24.2)	19.7 (19.0-20.2)
1	<i>Cactospiza p. pallida</i>	Duncan	66.0	43.2	15.8	9.8	8.0	7.2	23.2	19.2
10	<i>Cactospiza p. producta</i>	Albemarle	68.5 (66.0-72.0)	41.7 (39.5-43.5)	14.9 (14.0-16.2)	8.7 (8.2- 9.2)	7.7 (7.2-8.5)	6.6 (6.2-7.2)	22.7 (22.0-23.5)	19.2 (18.2-20.5)
3	<i>Cactospiza p. striatipennis</i>	Chatham	69.1 (68.0-70.2)	42.1 (41.2-43.2)	14.9 (14.5-15.5)	8.2 (8.0- 8.5)	8.6 (8.2-9.0)	7.0	22.7 (21.5-23.5)	19.9 (19.2-20.5)
10	<i>Cactospiza hirsutissima</i>	Albemarle	69.1 (65.0-72.2)	40.4 (37.0-43.2)	13.7 (12.0-14.5)	7.9 (7.5- 8.0)	7.5 (7.0-8.5)	6.6 (6.2-7.0)	22.0 (20.5-23.0)	18.9 (17.2-20.5)

Genus *CERTHIDEA* Gould

Certhidea Gould, Proc. Zool. Soc. London, pt. V, 1837, p. 7. (Type, *C. olivacea* Gould.)

Small Geospizidæ (the smallest of the family), with slender, acute bill (more so than in any other of the family); coloration usually plain, without striking color patterns, ranging from pale gray (almost white) to brownish, olive and yellowish; a tawny throat patch appears in greater or less distinctness in most of the forms. (See Ridgway, 1902, p. 761, for structural details.)

Represented in our collection by 430 specimens. In this material I find myself able to recognize eight forms of the genus. The most satisfactory nomenclatural treatment of these several forms is a far more difficult matter to determine upon than is the recognition of the features that characterize birds from the different islands, and any system at all that may be adopted is open to some adverse criticism. *Certhidea* occurs throughout the Galapagos Archipelago, upon all of the larger islands and on most of the small ones. Island variation affects color and pattern almost entirely, structural differences being very slight.

Variation between islands, and variation in series from any one island, is such as to suggest subspecific treatment of the different forms, and, in fact, it would be quite possible and logical, upon the basis of overlapping through individual variation, to regard the group as a monotypic genus and to treat all of the forms of *Certhidea*, widely different as some of them are, as subspecies of one species, *Certhidea olivacea* Gould. To do this, however, would in some instances necessitate the acceptance of intergradation between series from widely separated islands, with diverse forms interposed between, and it seems doubtful if such an arrangement would indicate in fact the actual relationships and the true manner of divergence between the several forms, as it would appear to do.

It would be possible again to make a fairly satisfactory arrangement of the forms in groups. One species, *C. olivacea*, with several possible subspecies, would occupy the central islands (James, Jarvis, Albemarle, Narborough, Duncan, Indefatigable, and Charles): another, *C. fusca*, with subspecies, would occupy outlying islands north and east (Culpepper, Wenman, Abingdon, Bindloe, Tower, Barrington, and Hood). The bird of Chatham Island (easternmost of the archipelago), *C. luteola*, would then be regarded as a third species: its resemblances lie toward typical *C. olivacea*. The

objections to this course are about the same as those of the first alternative, of regarding all the forms as subspecies of one species. The group divisions would have to be arbitrary to a certain extent.

One other method of treatment remains, that adopted by Ridgway (1902, p. 761), to regard each distinguishable form as a separate species. There are strong objections to this procedure also, for between certain of the described forms there exists individual intergradation just as we find between mainland birds that are accorded subspecific status, and there is also great variation in the amount of difference between different named forms. Nevertheless, despite the strong predilection that I felt for subspecific

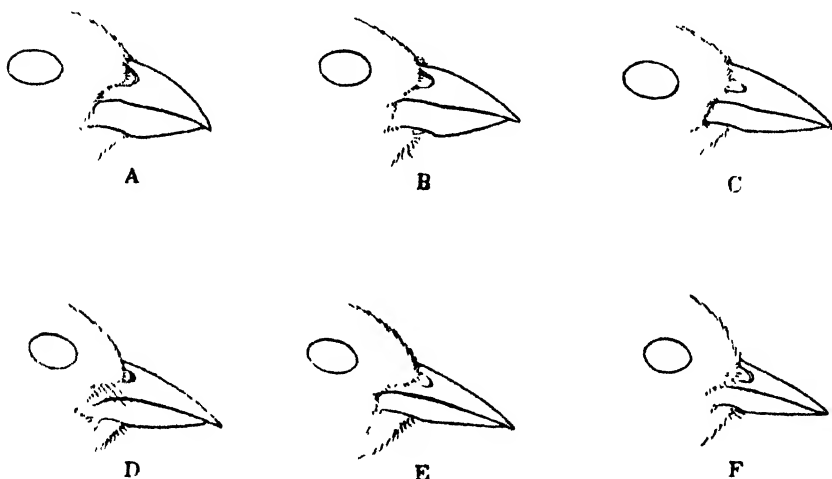


Fig. 55. Species of *Camarhynchus* and *Certhidea* showing intergradation in bill structure between the two genera. Slightly larger than natural size. A, *Camarhynchus parvulus* (no. 7756). B, *Camarhynchus aureus* (no. 8121). C, *Camarhynchus conjunctus* (no. 7713). D, *Certhidea ridgwayi*? (no. 4862). E, *Certhidea ridgwayi* (no. 4643). F, *Certhidea olivacea* (no. 4538).

treatment at the outset, it is Ridgways' course, of using a binomial for each form, that I have finally adopted. As a matter of fact, the outcome of a careful weighing of pros and cons in the different possible nomenclatural methods of treatment of *Certhidea*, is an almost total abandonment on my part of any attempt at expressing relationship through names. Binomials are used simply as a means of referring to the *Certhidea* population on the several islands or aggregation of islands that are inhabited by distinguishable forms.

A summary of the course of variation in *Certhidea* will perhaps help toward an understanding of the sort of complications that are encountered. There is one set of facts, and apparently just one, that can serve as a point of departure. These are the facts tending to show that it is on Charles Island that we must look for the best evidence of close relationship between *Certhidea* and *Camarhynchus*. A species of *Camarhynchus* (*C. conjunctus*) on Charles Island shows unmistakable likeness toward *Certhidea*, and the Charles Island *Certhidea* (*C. ridgwayi*) differs from other *Certhidea* in having a larger bill, in the juvenal plumage being distinctly streaked, and in traces of streaking dorsally remaining in older plumages, all of these features showing relationship toward *Camarhynchus*. The *Certhidean* resemblances of *ridgwayi* are toward *olivacea*, and to understand this approach a second start must be made from typical *olivacea*.

James Island is accepted as the type locality of this form, and I have lumped the birds from Jervis, Indefatigable, Seymour, Duncan, Albemarle, and Narborough islands under the same name. As it happens, it is on James Island that *olivacea* characters are developed to their greatest extreme; on some of the other islands there is variation from this standard almost sufficient to justify recognition subspecifically. Perhaps the outstanding feature of this "group" is the cinnamon-tawny throat patch, of most frequent occurrence and of greatest intensity on James Island specimens. Birds from Albemarle have this marking less deeply colored, on those from Indefatigable it is still more poorly defined, and on Charles Island birds (*ridgwayi*) this feature is even less distinct, though present, more or less dilute, on practically all our adult males. So, in a graded series resemblances can be traced in this regard, island by island, between the two extremes, on James and on Charles.

North and east of the *olivacea* aggregation is the "*Certhidea fusca* group," characterized by duller, more uniform coloration. Curiously, it is the northernmost, most remote birds, those on Culpepper and Wenman (*becki*), that show the first step from *olivacea*. In *becki* there is still a slight trace of the tawny throat of *olivacea*, and the general olivaceous color is not unlike that of James Island birds. The form on Abingdon and Bindloe islands (*fusca*) is much less olivaceous, being decidedly leaden gray in general color tone. The throat patch has nearly disappeared; in many cases

it is quite gone, and when present at all it is merely as a pale yellowish suffusion. The Tower Island bird (*mentalis*) exhibits

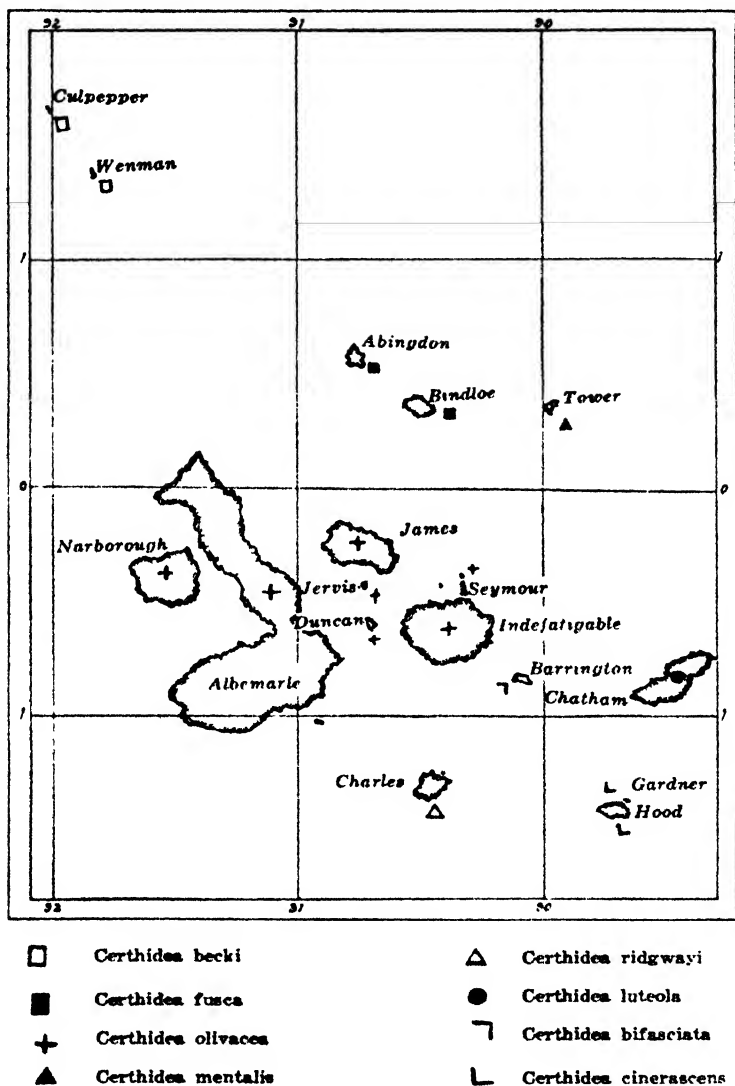


Fig. 56. Map showing distribution of the species of *Certhidea*. Symbols indicate islands where recorded.

an accentuation of the features of *fusca*, being still more grayish; the throat patch is about the same. On Hood Island, farthest to

the southward, the form *cinerascens* (superficially closely similar to *fusca*) passes from grayish to whitish, and the last vestige of color on the throat is lost. On Barrington Island the form *bifasciata* exhibits the extreme of whitish coloration in the genus, being pure white below and pale gray above. On Chatham, the easternmost island of the archipelago, a distinctly marked form, *luteola*, occurs, an intensely olive and yellow colored bird. This olivaceous coloration is an intensification of the shade seen in more richly colored examples of *olivacea*. but in *luteola* the tawny throat patch of *olivacea* does not appear.

101. *Certhidea olivacea* Gould

- Certhidea olivacea* Gould, 1837a, p. 7 (orig. descr.; Galapagos Ids.); 1841, p. 106, pl. 44 ("Chatham and James islands").—Sclater & Salvin, 1870, p. 323 (Indefatigable).—Salvin, 1876, p. 476.—Sclater, 1886, p. 28, part.—Ridgway, 1890, p. 105; 1897, p. 498; 1902, p. 763.—Gifford, 1919, p. 220, part.
- Certhidea olivacea olivacea* Rothschild & Hartert, 1899, p. 148; 1902, p. 384.—Snodgrass & Heller, 1904, p. 350.
- Certhidea salvini* Ridgway, 1894, p. 358 (orig. descr.; Indefatigable Id.); 1897, p. 500.—Hartert, 1919, p. 172 (particulars of type specimen, in Rothschild Museum).
- Certhidea albemarlei* Ridgway, 1894, p. 360 (orig. descr.; Albemarle Id.); 1897, p. 500.—Hartert, 1919, p. 172 (particulars of type specimen, in Rothschild Museum).

CERTHIDEA OLIVACEA Gould

Cotype.—British Museum, no. 55.12.19.120; C. Darwin.

Cotype.—British Museum, no. 55.12.19.127; C. Darwin.

Cotype.—British Museum, no. 55.12.19.164; C. Darwin.

Neither sex, locality, nor date are upon the labels of the above three specimens.

Cotype.—British Museum, no. 1837.2.21.408; Galapagos: Burnett and Fitzroy.*

CERTHIDEA SALVINI Ridgway

Type.—Rothschild Museum: ♂ ad.; Indefatigable Island; August 6, 1891; Dr. G. Baur; orig. no. 438.

CERTHIDEA ALBEMARLEI Ridgway

Type.—Rothschild Museum; (im., sex?); Albemarle Island; July 21 (1891); Dr. G. Baur; orig. no. 633.

In the description of this species Ridgway (1894, p. 360) gives

*James Island. Not a cotype. N.B.K.

the original number as 595 (see Hartert, 1919, p. 172), probably a slip of the pen, but suggesting also the possibility of the existence of another specimen, bearing that number.

Certhidea olivacea was described by Gould (1837a, p. 7) as from the "Galapagos Islands", no type indicated; described and figured later (1841, p. 106, pl. 44), and assumed to be from Chat-ham and James. In the British Museum there are four specimens that may be regarded as co-types, three collected by Darwin, one by Burnett and Fitzroy. Two of the Darwin specimens are "dis-mounted", with glass eyes and wired legs, and all four are dingy and discolored in appearance. Only one shows even a trace of cinnamon on the throat, a marking that is conspicuously present in Gould's colored plate, and in three of the four the bill is appreciably heavier than the average in James Island birds. Despite discrepancies (and apparently none of these birds is the original of Gould's plate) they are more nearly like James Island birds than any others, and James Island must be accepted as the type locality.

DESCRIPTION.—Adult male (James Island): Upper parts generally ranging (in different individuals) from drab to buffy brown, tending toward grayish on top of head, toward olivaceous on dorsum and rump. Exposed portions of wing coverts, remiges and rectrices of the same olive brown coloration. Lores, super-ciliary stripe, circle about eye, throat and upper breast, forming a fairly well defined area, vinaceous tawny in highly marked individuals, and ranging through paler stages to yellowish white, uniform with rest of under parts. Median portion of abdomen and under tail coverts, buffy yellow. Sides and flanks, brownish: the tawny throat patch extends down upon sides of breast to a greater or less extent. *Adult female* (James Island): Generally paler than the male. Grayish brown above, faintly tinged with olivaceous; almost uniformly buffy yellow below, slightly brighter on throat, paler on belly, and darker on sides. No trace of the cinnamon tawny throat patch appears on any female in our series from James Island. *Juvenal*: Three young birds from Albemarle, molting from juvenal plumage, are still mostly in that stage. The juvenal plumage is darker colored below than in the later stages, and cinnamon buffy edgings to the wing coverts give an effect of faintly indicated wing bars. There is no trace of spots or streaks on the ventral surface; they are uniformly colored below.

HABITAT.—James, Jervis, Indefatigable, Seymour, Duncan, Albemarle, and Narborough islands.

Represented in the Academy collection by 124 specimens (nos. 4537-4611, 4806-4840), collected during the following months. James Island: January, July, August, December. Albemarle Island: March, April, May, August, November. Indefatigable Island: January, July, October, November. Duncan Island: August, December. Jervis Island: December. South Seymour Island: July, November.

Although I am placing the birds from these several islands under the one name, *Certhidea olivacea*, there is some justification for Ridgway's (1894) separation of the forms occurring on Indefatigable and Albemarle. These are the two islands, besides James, that are adequately represented in our collection, and it might be that more extensive series from Jervis and Duncan would prove minor average differences to be existent in specimens from those islands as well.

Male birds from James Island show the most extreme development of the cinnamon-tawny throat patch. It is of more common occurrence than is the case on other islands, only two of the fifteen males from James Island not having the marking conspicuously present, and in the brightest colored specimens it is deeper colored than in any from other islands. Females from all the islands as a rule lack any indication of the throat patch; occasionally it is faintly shadowed. Albemarle birds (*Certhidea albemarleii* Ridgway) in comparable plumage are more olivaceous, compared to the more grayish colored James Island specimens, and the cinnamon-tawny throat is not so deeply colored. The throat patch is as commonly present as in the James Island series, but the marking is less conspicuous. Many of the Albemarle series have the greater and middle wing coverts with bright rufous tips, a marking that does not occur on James Island birds. The Indefatigable series (*Certhidea salvini* Ridgway) is again of an olivaceous color, but paler than the Albemarle birds, and the throat patch is even less conspicuous. It is present on perhaps two-thirds of the male birds, but on most of these it is scarcely more than indicated, and the brightest colored Indefatigable specimen is comparable to one of the duldest from James Island.

Briefly to summarize, James Island birds are grayish in body hues, especially dorsally, and the cinnamon throat patch is at its maximum development. Albemarle birds are olivaceous in body hues, with rufous wing bars commonly present, and with

the cinnamon throat patch reduced in intensity. Indefatigable birds are olivaceous in body hues, though slightly paler than those from Albemarle, and the cinnamon throat patch is less commonly present than in series from either of the other islands, and never so deeply colored as on James Island specimens.

The three specimens from South Seymour are, of course, indistinguishable from Indefatigable birds. The series from Jarvis is inadequate for the drawing of any conclusions. In the Duncan Island series, as on birds from the nearby Indefatigable Island, the cinnamon throat patch is very slightly developed, but the birds are in such worn plumage that had they ever possessed the olivaceous body color of the Indefatigable form, it is not now to be discerned. I have seen no specimens from Narborough, but presumably those would resemble the form upon Albemarle. Birds from the three large islands, James, Albemarle and Indefatigable, are thus shown to vary along certain definite lines, and to a sufficient degree so that the three forms might be regarded as deserving of separate names. The nature and extent of the differences, however, are such that it seems to me best to keep the three under one name. Even the most widely separated variants of this group are capable of segregation together as distinct from the other forms of *Certhidea*.

There are three birds in juvenal plumage from Albemarle Island, collected on March 19, April 14, and April 26, respectively. In these the bill is light colored. In midsummer birds (from May to August), some of which must be young of the year, the bill is light colored, except that in some late August specimens it is beginning to turn dusky. Undoubtedly mature males, that is with bright cinnamon throat patch, and adult females, taken in July and August, have the bill light colored, though with some dusky on the upper mandible. Male and female alike, taken from December to March almost invariably have the bill black. There are a few exceptions, in which the bill is dusky above and light colored below, but it may be said that black-billed birds are taken only during the time indicated, which is the breeding season. The annual molt takes place from late April probably into June.

102. *Certhidea fusca* Sclater & Salvin

Certhidea fusca Sclater & Salvin, 1870, pp. 323, 324 (orig. descr.; "Abingdon and Bindloe islands").—Salvin, 1876, p. 477.—Sclater, 1886, p. 28.—Ridgway, 1890, p. 105; 1897, p. 502; 1902, p. 766. *Certhidea olivacea fusca* Rothschild & Hartert, 1899, p. 151; 1902,

p. 385.—Rothschild, 1902a, p. 46 (nest and eggs).—Snodgrass & Heller, 1904, p. 352.

Certhidea olivacea Gifford, 1919, p. 220, part.

CERTHIDEA FUSCA Sclater & Salvin

Cotype.—British Museum, no. 75.4.2.56; ♂; Abingdon Island; December 29, 1868; Dr. A. Habel; orig. no. 97.

Cotype.—British Museum, no. 85.4.1.190; ♂; Abingdon Island; December 30, 1868; Dr. A. Habel; orig. no. 97.

Cotype.—British Museum, no. 85.4.1.191; ♂; Bindloe Island; November 12, 1868; Dr. A. Habel; orig. no. 83.

Certhidea fusca was based upon one specimen from Bindloe, three from Abingdon, no type or type locality designated. In the Catalogue of Birds (vol. XI, p. 23) Sclater lists three specimens, indicating one from Abingdon and one from Bindloe as "types of the species". There is nothing upon the labels to distinguish the type, but in the British Museum register no. 190 is so indicated. That bird is from Abingdon, which island may thus be accepted as the type locality.

The species *fusca* is described as having "rostro graciliore", compared with *olivacea*, and the bill is more slender than in Darwin's specimens that are the basis of *olivacea*. It is not more slender, though, than the mode of recently collected series of James Island birds.

DESCRIPTION.—*Adult male and female*: Sexes alike. A uniformly grayish appearing bird. Upper parts generally close to buffy olive; paler, more grayish, below; sides and flanks tinged with brownish. Eye ring and lores whitish.

HABITAT.—Abingdon and Bindloe islands.

Represented in the Academy collection by 10 specimens from Abingdon, 18 from Bindloe (nos. 4669-4674, 4798-4799, 4881-4900). Those from Abingdon were collected September 18 to 22, those from Bindloe, September 17 and 18. Of this series, 20 have the bill black or mostly black, in 8 it is light colored to a varying extent.

A grayer colored bird than *becki*, of Culpepper and Wenman, to the northward, but not so uniformly leaden colored as *mentalis*, of Tower Island, the most closely adjacent form and the one that *fusca* most nearly resembles.

103. *Certhidea becki* Rothschild

Certhidea becki Rothschild, 1898, p. liii (orig. descr.; Wenman Id.).

—Ridgway, 1902, p. 767.—Hartert, 1919, p. 172 (particulars of type specimen, in Rothschild Museum).

Certhidea olivacea becki Rothschild & Hartert, 1899, p. 149; 1902, p. 385.—Snodgrass & Heller, 1904, p. 354.

Certhidea olivacea mentalis Snodgrass & Heller, 1904, p. 353, part (Culpepper Id.).

Certhidea olivacea Gifford, 1919, p. 220, part.

Certhidea drownei Rothschild, 1898, p. liii (orig. descr.; Culpepper Id.).—Ridgway, 1902, p. 767.—Hartert, 1919, p. 172 (particulars of type specimen, in Rothschild Museum).

Certhidea olivacea drownei Rothschild & Hartert, 1899, p. 150.

CERTHIDEA BECKI Rothschild

Type.—Rothschild Museum; ♂ ad.; Wenman Island; July 31, 1897; C. D. Hull (Webster-Harris expedition); orig. no. 236.

CERTHIDEA DROWNEI Rothschild

Type.—Rothschild Museum; ♂ ad.; Culpepper Island, July 27, 1897; R. H. Beck (Webster-Harris expedition); orig. no. 148.

DESCRIPTION.—*Adult male and female*: Sexes alike. Upper parts generally close to light brownish olive, less olivaceous on head, more so on dorsum. Face, throat and upper breast, pale ochraceous (in varying degree in different specimens) over a vaguely defined area; middle of abdomen and under tail coverts whitish; sides and flanks olivaceous, slightly paler than back. Wing coverts, remiges and rectrices dusky, margined with olivaceous.

HABITAT.—Culpepper and Wenman islands.

Represented in our collection by eight specimens from Culpepper and five from Wenman, the Culpepper series collected on September 25, the Wenman series on September 24 and 25 (nos. 4675-4676, 4693, 4800-4802, 4901-4906, 4909). Of these specimens, nine have the bill black or dusky, in four it is mostly light colored.

The *Certhidea* occurring on Culpepper and Wenman is sufficiently distinct from the olivaceous aggregation of the central islands, and from *fusca* and *mentalis*, of Abingdon, Bindloe, and Tower, to justify its recognition, but our series shows no points of difference between the birds of Culpepper and Wenman. The forms *becki* (Wenman Island) and *drownei* (Culpepper Island) were described in the same paper; I am using the name *becki* as having priority on the page on which they both appeared.

Becki is the darkest colored, most olivaceous, of the forms of *Certhidea*. Occurring at the northernmost extreme from the central islands where *olivacea* is found, it differs from the mode of *olivacea* in much the same way as does the bird at the southernmost extreme—*ridgwayi*, of Charles Island. These two widely separated forms have similarly acquired nearly uniform coloration, but each with enough trace of the tawny throat remaining to indicate close relationship to *olivacea*. *Becki* is appreciably darker colored, and has even less of the throat patch than *ridgwayi*; in *becki*, in fact, it is barely indicated. In two of the five specimens from Wenman Island (nos. 4800, 4801) the bill is light colored, the plumage is more worn than in the rest of the series (from both islands) and they still show traces of molt. These birds are grayer than the rest, approaching *mentalis* in appearance. Possibly these are young-of-the-year, a possibility that is borne out by the fact that they are the only ones of the *becki* series with distinctly light colored bills.

104. *Certhidea mentalis* Ridgway

Certhidea mentalis Ridgway, 1894, p. 359 (orig. descr.; Tower Id.); 1897, p. 504; 1902, p. 766.—Hartert, 1919, p. 172 (particulars of type specimen, in Rothschild Museum).

Certhidea olivacea mentalis Rothschild & Hartert, 1899, p. 150.—Snodgrass & Heller, 1904, p. 353.

Certhidea olivacea Gifford, 1919, p. 220, part.

CERTHIDEA MENTALIS Ridgway

Type.—Rothschild Museum; ad., sex.?; Tower Island; September 2, 1891; Dr. G. Baur; orig. no. 594; "from spirits."

DESCRIPTION.—*Adult male and female*: Sexes alike, and almost uniformly colored. In fairly fresh plumage close to drab on the upper parts, which fades to a clearer gray in worn specimens. Under parts paler, tinged with olivaceous brown on sides. Eye ring and lores whitish, upper throat sometimes faintly tinged with buffy. A freshly molted bird (Stanford Univ. Museum, no. 5186, female, June 23, 1899) is slightly more brown above and more buffy on the breast, than is the case in our September-taken specimens.

HABITAT.—Tower Island.

Represented in our collection by 18 specimens, collected on

September 14, 15 and 18 (nos. 4677-4692, 4907-4908). The bill is black throughout the series except for three birds in which the lower mandible is light colored basally.

This is a well marked form, distinguished by its almost uniformly dull leaden coloration. There is a faint suggestion of a paler area on the throat, a reminder of the tawny throat patch of *olivacea*, and the center of the belly is dull whitish, in slight contrast to the leaden gray sides. Some individuals of *C. fusca* from Abingdon and Bindloe approach *mentalis* in being of a more uniformly gray coloration than is the mode of *fusca*, but the two series, lined up in opposing rows of skins, are readily distinguished. *Fusca* is distinctly more whitish below and with more of an olivaceous tinge throughout, *mentalis* is uniformly leaden gray.

105. *Certhidea ridgwayi* Rothschild & Hartert

Certhidea olivacea ridgwayi Rothschild & Hartert, 1899, p. 149 (orig. descr.; Charles Island.)—Snodgrass & Heller, 1904, p. 352.—Hartert, 1919, p. 149 (particulars of type specimen, in Rothschild Museum).

Certhidea ridgwayi Ridgway, 1902, p. 765.

Certhidea olivacea Gifford, 1919, p. 220, part.

CERTHIDEA OLIVACEA RIDGWAYI Rothschild & Hartert

Type.—Rothschild Museum; ♂ ad.; Charles Island; November 5. 1897; C. D. Hull (Webster-Harris expedition); orig. no. 2308.

DESCRIPTION.—*Adult male*: Generally similar to the corresponding stage in *C. olivacea*, but more gray on upper parts and paler, less yellowish, below. Cinnamon-tawny marking on face and throat present as in *olivacea* but paler, more dilute, and more restricted as to area. *Adult female*: As in *C. olivacea* but generally paler colored. *Juvenal*: Sexes alike. Widely different from young *olivacea* in being heavily streaked below, faintly streaked on the back. Top of head blackish; feathers of upper parts (dorsum, scapulars, etc.) with blackish centers, margined to a varying extent with olivaceous; wing coverts edged with cinnamon rufous, producing two fairly well defined bars across the wing; remiges and rectrices dusky, margined with rufescent or olivaceous edgings; throat dirty whitish, unmarked; sides of face blackish; fairly well defined blackish malar streaks; under parts in general (except throat, mid-abdomen, and lower tail coverts) whitish, with heavy longitudinal blackish streaks; sides with a brownish tinge.

HABITAT.—Charles Island.

Represented in our collection by 53 specimens (nos. 4642-4668, 4795-4797, 4858-4880), collected during February, March, May, June, and October. Black bills predominate in birds taken during October, February, and March, though there are a few in each month in which it is light colored or dusky. All young birds and all adults collected in May and June have the bill light colored.

This form, in the further reduction of the tawny throat patch, represents a step beyond that reached by *olivacea* of Indefatigable Island. Practically all of the adult males of *ridgwayi* in our series show more or less distinct traces of this marking, but the color is pale and washed out, widely spread over the breast in many cases but with poorly defined boundaries. *Ridgwayi* is paler colored throughout than *olivacea*, especially below. The wing bars are on the average distinctly marked and bright rufous, as in *olivacea* from Albemarle. I can not verify the supposedly broader whitish tips to the rectrices of *ridgwayi*, as described by Rothschild & Hartert. I can, however, uphold the statement of those authors regarding the bill of *ridgwayi*, that it "is perhaps generally a little stouter." It is appreciably heavier than in any other form of *Certhidea*, among which there is otherwise little variation in bill structure, and this is a character of some significance, considered in connection with the interrelationships of *Certhidea* and *Camarhynchus*.

The juvenal plumage of *ridgwayi* differs from the later stages in being streaked above and below. This condition persists to some extent through the later plumage stages, for many adults of *ridgwayi* show traces of such markings, in contrast to the uniformly plain coloration in all other forms of *Certhidea*. Specimens of young *olivacea* at hand are plain colored, with no streaks above or below, a juvenal of *mentalis* at hand (in the Stanford University collection) is also plain colored below, and published descriptions of the young of other forms describe them as plain colored, similar to the adults. The streaked condition of the young of *ridgwayi* is again of significance as regards the relationship of *Certhidea* and *Camarhynchus*. Young of *ridgwayi* and young of some forms of *Camarhynchus* are closely similar in color and markings.

Some young males of *ridgwayi* undergoing the post-juvenal molt are acquiring on the breast buff-colored feathers that are distinctly

richer colored than in the adult female. Apparently they are assuming the tawny throat patch in nearly as full intensity as is ever attained in this form.

In its general resemblance to *olivacea*, and from the manner in which the adult male of *ridgwayi* apparently exemplifies a stage differing from *olivacea* of James Island but a step farther than does the male of Indefatigable, it might be assumed that *ridgwayi* should be treated as a subspecies of *olivacea*, as has been done by Rothschild & Hartert and by Snodgrass & Heller. The difference in the juvenal plumage, however, seems to preclude any such treatment, and the difference in thickness of bill, too, though apparently a slight feature, is nevertheless of sufficient importance to weigh heavily against subspecific treatment.

There is one specimen in the series (no. 4862, female, May 29, 1906) that I can only tentatively regard as an example of *ridgwayi*. The bill of this bird is so much heavier than normal as to suggest the possibility of its being an immature example of *Camarhynchus conjunctus*, of which only the adult male plumage is known. In the bird in question the bill is shaped as in *Certhidea ridgwayi*, but is both heavier and longer. It is as heavy as in *Camarhynchus*, but differently shaped, being somewhat longer. (See fig. 55, D.)

106. *Certhidea luteola* Ridgway

Certhidea luteola Ridgway, 1894, p. 360 (orig. descr.; Chatham Id.); 1897, p. 501; 1902, p. 764.—Hartert, 1919, p. 172 (particulars of type specimen, in Rothschild Museum).

Certhidea olivacea luteola Rothschild & Hartert, 1899, p. 149; 1902, p. 385.—Snodgrass & Heller, 1904, p. 351.

Certhidea olivacea Sclater, 1886, p. 28, part.—Ridgway, 1890, p. 105, part.—Gifford, 1919, p. 220, part.

CERTHIDEA LUTEOLA Ridgway

Type.—Rothschild Museum; ♂ ad.: Chatham Island; June 17, 1891; Dr. G. Baur; orig. no. 56.

DESCRIPTION.—*Adult male and female*: Sexes alike. A yellowish appearing bird. Upper parts generally close to buffy citrine in fresh plumage, approaching light brownish olive in more worn condition. Under parts paler, more yellowish; middle of abdomen and lower tail coverts whitish; sides and flanks tinged with brownish. Eye ring and lores whitish or yellowish. Upper throat sometimes tinged with brighter saffron than rest of under parts.

A young bird (juvenal plumage) in the Rothschild Museum is uniformly colored below, but another in juvenal plumage in the United States National Museum (no. 316948) is heavily streaked, as in the young of *C. ridgwayi*. For this lack of uniformity there is no explanation at present.

HABITAT.—Chatham Island.

Represented in the Academy collection by 51 specimens (nos. 4612-4641, 4791-4794, 4841-4857), collected during January, February, July, September, and October. The bill in all July specimens (5 in number) is light colored; in September and October birds it is mostly light colored, in a few it is black and in a few intermediate; in January and February birds (19 in number) the bill is black in all but two.

In this form the sexes are alike, both lacking the rufous throat marking that is seen on the male of *C. olivacea*. According to Rothschild & Hartert (1899, p. 149) and Snodgrass & Heller (1904, p. 351) an indication of this feature is occasionally present on Chatham Island birds, but no trace of it is to be seen among the males of our series, though there is in some cases an intensification on the throat of the generally yellowish ventral coloration. In general coloration *luteola* resembles the non-rufous throated examples of *olivacea*, as represented on Albemarle and Indefatigable, but it is even brighter olivaceous above and brighter yellow below. Neither the juvenal plumage nor the molts are represented in our series.

107. *Certhidea cinerascens* Ridgway

Certhidea cinerascens Ridgway, 1890, p. 105 (orig. descr.; Hood Id.);

1897, p. 503; 1902, p. 768.—Gifford, 1919, p. 223, part.

Certhidea cinerascens cinerascens Rothschild & Hartert, 1899, p.

151.—Snodgrass & Heller, 1904, p. 354.

Certhidea olivascens (lapsus calami) Ridgway, 1890, p. 124.

CERTHIDEA CINERASCENS Ridgway

Type.—United States National Museum, no. 116069; ♂ ad.; Hood Island; April 7 (1888); U. S. Fish Commission, Voyage of Albatross, 1887-88.

DESCRIPTION.—*Adult male and female*: Sexes alike. A uniformly grayish appearing bird. Upper parts generally close to grayish olive; whitish below. Eye ring and lores whitish. Slightly paler edges to wing coverts produce faintly indicated wing bars.

HABITAT.—Hood Island and Gardner-near-Hood.

Our series consists of 34 skins from Hood Island, and 58 from Gardner-near-Hood (nos. 4694-4747, 4803-4804, 4910-4945). The Hood Island series was collected on January 31, February 1 and 3, June 23 and 28, July 2, and September 25 and 27. The Gardner Island series was collected on February 3, June 23 and 27, September 28, 29, and 30. In January and February birds (28 in number) the bill is black in nearly every case; in a few individuals the lower mandible is light colored basally. In June and July specimens (16) the bill is light colored. In September specimens (48) the bill is light colored in nearly every case; in a few it is dusky, in just one is it as black as in January and February skins.

On a basis of resemblance *cinerascens* and *fusca* might well be regarded as two slightly differentiated subspecies. Birds from Abingdon and Bindloe (*fusca*) on the one hand, and from Hood and Gardner (*cinerascens*) on the other, are, in fact, so closely similar that were the islands closely adjoining they might all be placed under one name. There is no greater difference in the two lots than there is between specimens of *olivacea* from James and Albemarle islands.

In the Abingdon-Bindloe series there is a greater number of darker, more grayish colored birds, in the Hood-Gardner series a larger proportion of paler, more whitish colored ones. But there are many skins in comparable plumage in the two lots that are indistinguishable in appearance. Similarly as to the supposed differences in length of bill (*fusca* has been described as having a slightly longer bill), there is a greater proportion of specimens of *fusca* in the entire series that approach the maximum measurements and a greater number of *cinerascens* that approach the minimum, but there are many in the two lots that are exactly alike. The differences between *fusca* and *cinerascens*, remote as are their island habitats, are slight and elusive, and are only apparent at all in large series of skins.

108. *Certhidea bifasciata* Ridgway

Certhidea bifasciata Ridgway, 1894, p. 359 (orig. descr.; Barrington Id.); 1897, p. 504; 1902, p. 768.—Hartert, 1919, p. 171 (particulars of type specimen, in Rothschild Museum).

Certhidea cinerascens bifasciata Rothschild & Hartert, 1899, p. 151.—Snodgrass & Heller, 1904, p. 356.

Certhidea cinerascens Gifford, 1919, p. 223, part.

CERTHIDEA BIFASCIATA Ridgway

Type.—Rothschild Museum; ad., sex?; Barrington Island: Dr.

G. Baur; orig. no. 593; "from spirits." In Ridgway's description the date of capture is given as July 9, 1891; there is no date upon any of the three labels now attached to the specimen.

DESCRIPTION.—*Adult male and female*: Sexes alike. The palest colored form of *Certhidea*. A uniformly whitish appearing bird. Upper parts generally gray with scarce a tinge of olivaceous. Below pure white, tinged with grayish on flanks and occasionally with a faint tinge of yellowish on throat. Lores, eye ring, and a fairly well defined superciliary stripe white. *Juvenal* (male, coll. Stanford University Museum, no. 4922; May 29, 1899): Essentially like the adult, but not so purely white below and darker on the flanks. Upper surface rather darker than in the adult, and feathers of dorsum with obscurely indicated dusky cross bars.

HABITAT.—Barrington Island.

Our series comprises 53 skins (nos. 4748-4790, 4805, 4946-4968). Forty-six specimens were collected from October 20 to 24, the remaining seven on July 9 and 10. One of the July specimens has the bill dusky, and on ten of the October birds it is black or mostly dusky. *Bifasciata* is a well marked form, the palest colored of any of the *Certhidea*. The color characters hold good nearly throughout the series, but the gap between *cinerascens* and *bifasciata* is definitely bridged by individual variants in both lots.

SPECIMENS OF THE SPECIES OF *Certhidea* IN THE ACADEMY COLLECTION AND (FIGURES IN PARENTHESIS) IN THE STANFORD UNIVERSITY COLLECTION

Name	Island	Male	Female	Young	Sex undetermined
<i>Certhidea becki</i>	Culpepper	2	6		
<i>Certhidea becki</i>	Wenman	1 (1)	1		3
<i>Certhidea fusca</i>	Abingdon	3	7		
<i>Certhidea fusca</i>	Bindloe	3	13		2
<i>Certhidea mentalis</i>	Tower	16	2 (1)		
<i>Certhidea olivacea</i>	James	15	8		2
<i>Certhidea olivacea</i>	Jervis	3	1		
<i>Certhidea olivacea</i>	Seymour	2			1
<i>Certhidea olivacea</i>	Indefatigable	28	19		8
<i>Certhidea olivacea</i>	Duncan	7	2		2
<i>Certhidea olivacea</i>	Albemarle	18 (1)	5	3	(1)
<i>Certhidea bifasciata</i>	Barrington	30 (2)	22 (2)	(1)	1
<i>Certhidea luteola</i>	Chatham	30	17		4
<i>Certhidea cinerascens</i>	Hood	19 (3)	15		1
<i>Certhidea cinerascens</i>	Gardner-near-Hood	36 (4)	20		1
<i>Certhidea ridgwayi</i>	Charles	20	19	12	1

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM) OF THE
SPECIES OF *Certhidea*

MALES

Number of specimens	Species	Island	Wing	Tail	Culmen	Tarsus	Middle toe with claw
2	<i>Certhidea becki</i>	Culpepper	55.0-56.5	37.0-38.5	9.2-10.0	21.0-21.0	14.0-14.5
2	<i>Certhidea becki</i>	Wenman	51.5-54.5	37.5-38.0	9.0-10.0	19.2-20.0	14.0-14.5
3	<i>Certhidea fusca</i>	Abingdon	49.3 (49.0-50.0)	31.2 (32.5-36.0)	9.5 (9.0-10.2)	20.1 (19.0-21.0)	13.9 (13.2-14.5)
3	<i>Certhidea fusca</i>	Hindloe	53.7 (53.0-54.0)	36.2 (37.5-39.0)	9.3 (9.2- 9.5)	19.0 (19.0-19.0)	13.6 (13.2-14.0)
10	<i>Certhidea mentalis</i>	Tower	53.3 (52.5-54.2)	37.1 (35.5-38.2)	9.4 (9.5-10.0)	19.9 (19.2-20.2)	13.6 (13.0-14.0)
10	<i>Certhidea olivacea</i>	James	52.5 (50.5-55.0)	35.5 (34.5-37.0)	9.2 (8.5-10.0)	20.6 (20.0-21.2)	13.5 (12.5-14.0)
10	<i>Certhidea olivacea</i>	Indefatigable	53.0 (52.0-54.5)	36.7 (36.0-38.5)	9.8 (9.0-10.2)	20.8 (20.0-21.0)	13.8 (13.0-15.0)
7	<i>Certhidea olivacea</i>	Duncan	51.6 (51.0-52.2)	36.5 (34.5-37.5)	9.9 (9.5-10.2)	19.8 (19.0-20.5)	13.9 (13.2-14.5)
10	<i>Certhidea olivacea</i>	Albemarle	52.4 (51.0-53.2)	37.0 (33.0-40.0)	9.6 (9.2-10.0)	20.8 (20.0-22.0)	13.9 (13.0-14.5)
10	<i>Certhidea lutcola</i>	Chatham	52.5 (51.0-54.2)	37.4 (36.0-38.5)	9.9 (9.5-11.0)	20.6 (20.0-21.0)	13.7 (13.0-14.5)
10	<i>Certhidea ridgwayi</i>	Charles	53.7 (51.2-55.2)	37.5 (36.0-40.0)	9.7 (9.2-10.0)	20.6 (20.0-21.2)	13.9 (13.0-14.5)
10	<i>Certhidea cinerascens</i>	Hood	51.9 (50.2-53.0)	39.7 (37.2-41.5)	9.4 (9.0-10.0)	18.9 (18.0-19.5)	13.7 (13.0-14.5)
10	<i>Certhidea cinerascens</i>	Gardner-near-Hood	52.4 (51.0-54.0)	40.2 (38.5-41.5)	9.8 (9.2-10.5)	19.0 (18.5-19.5)	14.1 (13.2-14.8)
10	<i>Certhidea bifasciata</i>	Barrington	51.4 (50.5-53.5)	38.0 (37.0-39.2)	9.1 (8.8-10.0)	19.1 (18.2-19.8)	13.7 (13.2-14.5)

FEMALES

6	<i>Certhidea becki</i>	Culpepper	54.9 (54.0-55.5)	38.6 (36.0-40.0)	10.2 (9.5-10.5)	19.7 (19.0-20.0)	14.5 (14.5-14.5)
1	<i>Certhidea becki</i>	Wenman	55.0	39.5	10.0	20.0	14.0
7	<i>Certhidea fusca</i>	Abingdon	49.9 (49.0-50.5)	34.3 (32.0-36.0)	10.0 (9.0-10.5)	19.6 (19.0-20.2)	13.7 (13.0-14.2)
10	<i>Certhidea fusca</i>	Hindloe	52.4 (51.0-55.0)	36.3 (35.0-38.0)	10.5 (9.5-12.5)	19.7 (19.0-20.0)	13.8 (13.0-14.5)
2	<i>Certhidea mentalis</i>	Tower	53.0-53.5	36.0-37.5	10.0-10.8	19.8-20.0	14.2-14.5
8	<i>Certhidea olivacea</i>	James	52.0 (51.2-53.2)	34.2 (31.5-36.0)	10.3 (10.0-11.0)	20.6 (20.0-21.2)	14.2 (13.5-15.0)
10	<i>Certhidea olivacea</i>	Indefatigable	52.2 (50.2-55.0)	35.9 (34.5-38.8)	10.6 (9.5-11.0)	20.5 (20.0-21.0)	14.2 (13.2-15.0)
2	<i>Certhidea olivacea</i>	Duncan	49.0-50.0	32.5-35.5	11.0-11.5	20.0-21.0	15.0-15.0
5	<i>Certhidea olivacea</i>	Albemarle	51.3 (50.5-52.0)	34.5 (33.0-36.0)	10.1 (9.5-10.5)	19.9 (19.0-21.5)	14.9 (14.5-15.5)
10	<i>Certhidea lutcola</i>	Chatham	51.9 (49.5-54.4)	36.1 (33.0-38.5)	10.4 (9.8-11.0)	20.5 (19.8-21.5)	15.1 (14.2-16.0)
10	<i>Certhidea ridgwayi</i>	Charles	52.4 (51.5-53.0)	36.2 (34.5-38.0)	10.7 (10.0-11.0)	20.3 (19.5-21.2)	14.6 (14.0-15.0)
10	<i>Certhidea cinerascens</i>	Hood	52.1 (51.0-53.0)	38.3 (36.4-42.0)	10.8 (9.5-11.5)	18.7 (18.0-20.5)	13.9 (13.2-14.5)
10	<i>Certhidea cinerascens</i>	Gardner-near-Hood	51.5 (49.8-53.0)	39.2 (37.8-41.5)	10.4 (9.8-11.0)	18.6 (18.2-19.0)	14.2 (14.0-14.5)
10	<i>Certhidea bifasciata</i>	Barrington	50.9 (50.2-52.0)	35.9 (34.2-37.0)	10.3 (9.8-10.8)	19.3 (18.2-20.0)	13.6 (13.0-14.0)

Genus PINAROLOXIAS Sharpe

Pinaroloxias Sharpe, Cat. Birds Brit. Mus., X, 1885, p. 52, fig. (Type, *Cactornis inornata* Gould.)

Cocornis Townsend, Bull. Mus. Comp. Zool., XXVII, no. 3, 1895, p. 123. (Type, *Cocornis agassizi* Townsend.)

Geospizidæ of medium size (wing about 68 mm.); coloration, in the adult male uniformly black except that the under tail coverts are varied with buff; female and young streaked (plumage in its several variations essentially as in *Geospiza*); bill slender, sharp-pointed and decurved, culmen curved, gonys straight; tarsus relatively long, ratio of "middle toe with claw" to tarsus about 8 : 10. (See Ridgway, 1901, p. 516, for structural details.)

Pinaroloxias inornata (Gould)

Cactornis inornata Gould, 1843, p. 104 (based upon a specimen supposed to have come from Bow Island, Low Archipelago, Polynesia); 1844, p. 42, pl. 25.

Loxops inornata Gray, 1859, p. 28.

[Genus ?] *inornata* Salvin, 1876, p. 485 (discussion of systematic position).

Pinaroloxias inornata Sharpe, 1885, p. 52, fig. (establishment of genus *Pinaroloxias*); 1909, p. 193 (Cocos Id.).—Richmond, 1902, p. 247 (important discussion of history and nomenclature).—Gifford, 1919, p. 242 (life history).

Cocornis agassizi Townsend, 1895, p. 123, col. pl. (Cocos Id.; new genus and species; type in U. S. Nat. Mus.).—Ridgway, 1901, p. 516.—Rothschild, 1902, p. 6.—Snodgrass & Heller, 1902, p. 518.

HABITAT.—Cocos Island, Costa Rica.

CACTORNIS INORNATA Gould

Type.—British Museum, no. 56.3.15.8: (♀?); "Bow Island" (= Cocos Island, Costa Rica); (no date); received from Dr. Hinds.

COCORNIS AGASSIZI Townsend

Type.—United States National Museum, no. 131680; ♂ ad.; "Cocos Island, Pacific Ocean;" February 28, 1891; C. H. Townsend.

DESCRIPTION.—*Adult male*.—Uniform black except that the lower tail coverts are generally more or less broadly margined with pale buffy. These buffy margins are sometimes so broad as to almost entirely hide the black centers of the feathers, sometimes (rarely) so nearly absent as to be discerned with difficulty. *Adult female*.—Dusky olivaceous in general appearance. Feathers of upper parts

blackish, edged (broadly, narrowly, or hardly at all) with olivaceous. Feathers of rump so broadly margined as to hide the basal dark color, and rump consequently uniformly olivaceous, or (in very dark colored specimens) cinnamomeus. Under parts yellowish buff, paler on the abdomen, brownish on sides and flanks. Below generally streaked with dusky, most heavily on breast and sides, least on throat and lower belly. Under tail coverts buffy yellow, unmarked or with a few faint streaks. Greater and median wing coverts tipped with cinnamomeus, producing two well defined wing bars. Remiges dusky, narrowly edged with olivaceous; edgings broader and more cinnamomeus on tertials. Rectrices dusky, edged and tipped with olivaceous and cinnamomeus. There is considerable variation in general coloration (some darker, some paler), and in amount and extent of ventral streaking.

Males that are presumably immature are in a streaked plumage indistinguishable from females. Eleven males at hand are in parti-colored plumage, blotched with black and with streaked feathers



Fig. 57. *Pinaroloxias inornata*, male (no. 7422), Cocos Island.

in various degrees. These birds are not molting apparently, for no pin feathers are to be seen. No birds in juvenal plumage are in the series.

There are at hand 120 specimens in the Academy collection (nos. 7408-7521, 30633-30638) and seven from the Stanford University collection. Of the Academy series, 114 were collected September 4 to 13, 1905. and six on December 9, 1927; the Stanford University series was collected on June 30, 1899. The Academy series consists of 44 black males, 11 parti-colored males, 19 streaked males, 39 females, 7 sex not determined.

Of the black males, one September bird has a parti-colored bill: in all the others it is black. Of the parti-colored males (September), all have the bill dusky, not black. Of the streaked males (September), one has a jet black bill, one dusky, 17 pale colored.

Of the 39 females (September), 23 have a black bill, 16 pale colored or (a few) dusky. Of the Stanford Museum specimens, collected June 30, the two black males have the bill black, two streaked males dusky, two females pale colored.

There seems to be no reason to doubt that *Pinaroloxias* belongs to the Geospizidæ, the only member of the group found elsewhere than in the Galapagos Islands. Its plumages, so far as they are known, parallel those of *Geospiza*; in bill structure and general size it is more nearly like *Certhidea*.

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM) OF
Pinaroloxias inornata

Number of specimens	Wing	Tail	Culmen	MALES				Middle toe with claw
				Gonys	Depth of bill at base	Width of mandible at base	Tarsus	
10	65.9 (63.8-68.5)	41.8 (40.0-44.2)	12.9 (12.0-13.5)	8.1 (7.8-8.5)	5.6 (5.2-6.2)	5.1 (5.0-5.2)	21.4 (21.0-22.2)	17.4 (17.0-18.0)
				FEMALES				
10	63.8 (62.2-65.0)	40.0 (39.0-42.0)	13.0 (12.2-13.5)	8.1 (7.8-8.2)	5.4 (5.2-5.5)	4.9 (4.5-5.2)	20.4 (19.8-21.2)	16.4 (15.5-17.0)

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 Descriptions of one genus and three subgenera (which, however, are treated as full genera), under the following names: *Geospiza* (type, *G. magnirostris*, and including also *G. strenua*, *G. fortis*, *G. nebulosa*, *G. fuliginosa*, *G. dentirostris*, *G. parvula*, *G. dubia*); *Camarhynchus*, subgenus (type, *C. psittacula*, and including also *C. crassirostris*); *Cactornis*, subgenus (type, *C. scandens*, and including also *C. assimilis*); *Certhidea*, subgenus (type, *C. olivacea*).
- 1837b. Gould, J. [Remarks on raptorial birds in Mr. Darwin's collection, with descriptions of new species.] Proc. Zool. Soc. London, pt. v, pp. 9-11.
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50 col. pl. The separate parts were issued as follows: pp. 1-16, July, 1838; pp. 17-32, January, 1839; pp. 33-56, July, 1839; pp. 57-96, November, 1839; pp. 97-164, March, 1841. (See Sherborn, Ann. Mag. Nat. Hist., XX, sixth series, 1897, 483.)

"Most of the Galapagoan species had been previously described by Mr. Gould in Proc. Zool. Soc. London, Pt. V, 1837, pp. 4-7, 9-11, 22, and 26-27, but the following are additional thereto: *Strix punctatissima*, "G. R. Gray," p. 34, pl. IV (James Island); *Pyrocephalus nanus*, p. 45, pl. VII; *Pyrocephalus dubius*, p. 46; *Myiobius magnirostris*, p. 48, pl. VIII (Chatham Island); *Sylvicola aureola*, p. 86, pl. XXVIII; *Zenaida galapagoensis*, p. 115, pl. XLVI; *Totanus fuliginosus*, p. 130; *Zapornia spilonata*, p. 132, pl. XLIX; *Larus fuliginosus*, p. 141. (The locality, except where otherwise stated above, is given simply as 'Galapagos Archipelago.') The following previously described species are figured: *Crucirix galapagoensis*, pl. II; *Otus galapagoensis*, pl. III; *Progne modestus*, pl. V; *Mimus trifasciatus*, pl. XVI; *M. melanotis*, pl. XVII; *M. parvulus*, pl. XVIII; *Geospiza magnirostris*, pl. XXXVI; *G. strenua*, pl. XXXVII; *G. fortis*, pl. XXXVIII; *G. parvula*, pl. XXXIX; *Camarhynchus psittacula*, pl. XL; *C. crassirostris*, pl. XLI; *Cactornis scandens*, pl. XLII; *C. assimilis*, pl. XLIII; *Certhidea olivacea*, pl. XLIV. *Crucirix* (type, *Polyborus galapagoensis*, Gould), p. 22, is described as a new genus" (Ridgway).

1841. Gray, George Robert. (See Gould, J.)

1843. Gould, J. Descriptions of nine new species of birds collected during the recent voyage of H. M. S. Sulphur. Proc. Zool. Soc. London, pp. 103-106.

One of the newly described forms is *Cactornis inornata*, supposedly from Polynesia, but shown at a much later date (Richmond, 1902) to be the same bird that was named by Townsend (1895) *Cocornis agassizi*, from Cocos Island.

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1869. Sundevall, Carl J. Öfversigt of fogelslägtet Dendroeca. Öfvers. af K. Vetensk. Ak. Förhandl., Stockholm, pp. 605-618. (Not seen by me.)
1870. Sclater, P. L., and Salvin, Osbert. Characters of new Species of Birds collected by Dr. Habel in the Galapagos Islands. Proc. Zool. Soc. London, pp. 322-327, 6 text figs.
"Based on a collection made by Dr. A. Habel, of New York, the total number of specimens being 460, representing three islands, as follows: Indefatigable Island (267 specimens); Bindloe Island (94); Abingdon Island (84); island unspecified (15). A list of the 37 species is given on page 323, showing the number of specimens collected of each, and also the number of specimens procured on each island. The new species described are as follows: (1) *Certhidea fusca*, p. 324, fig. 1, Abingdon and Bindloe islands; (2) *Camarhynchus variegatus*,

p. 324, fig. 2, Abingdon and Bindloe islands; (3) *Camarhynchus habeli*, p. 325, fig. 3, Abingdon and Bindloe islands; (4) *Camarhynchus prothemelas*, p. 325, fig. 4, Indefatigable Island; (5) *Cactornis abingdoni*, p. 326, fig. 5, Abingdon Island; (6) *Cactornis pallida*, p. 327, fig. 6, Indefatigable Island; (7) *Nycticorax pauper*, p. 327, Indefatigable Island" (Ridgway).

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Nat. Mus., XII, 1889 (Feb. 5, 1890), pp. 101-128, 6 text figs.

"Based upon a collection made, in April, 1888, by Prof. Leslie A. Lee, naturalist of the expedition, assisted by Mr. Charles H. Townsend and Mr. Thomas Lee.

"Forty-seven species are mentioned, of which the following are described as new: (1) *Nesomimus* (new genus: Type, *Orpheus melanotis*, Gould) *macdonaldi*, Hood Island, p. 103, fig. 1; (2) *Nesomimus personatus*, Abingdon Island, p. 104; (3) *Certhidea cinerascens*, Hood Island, p. 105; (4) *Geospiza conirostris*, Hood Island, p. 106, fig. 2; (5) *Geospiza media*, Hood Island, p. 107, fig. 3; (6) *Cactornis brevirostris*, Charles Island, p. 108, fig. 4; (7) *Camarhynchus townsendi*, Charles Island, p. 110, fig. 5; (8) *Camarhynchus pauper*, Charles Island, p. 111, fig. 6; (9) *Pæcilonetta galapagensis*, Charles Island, p. 115. Besides these, two other species were named provisionally, as follows: *Cactornis hypoleuca* (if distinct from *C. pallida*, Sclater and Salvin), James Island, p. 109, in text; *Pyrocephalus minimus*, Chatham Island, p. 113, in text" (Ridgway).

1890. Townsend, C. H. Scientific results of explorations by the U. S. Fish Commission steamer Albatross. No. XIV. Birds from the coasts of western North America and adjacent islands, collected in 1888-89, with descriptions of new species. Proc. U. S. Nat. Mus., XIII, Sept. 9, 1890, pp. 131-142.
- 1891a. Baur, George Hermann Carl Ludwig. On the origin of the Galapagos Islands. Am. Nat., XXV, pp. 217-229, 307-319.
 "Dr. Baur's theory is that the Galapagos are continental islands, originated through subsidence. . . . This paper was written before Dr. Baur visited the Galapagos" (Ridgway).
- 1891b. Baur, G. [Comments upon the distribution of birds and reptiles on the Galapagos Islands.] Am. Nat., XXV, pp. 902-907.
1891. Shelley, G. E. Catalogue of the Picariæ in the collection of the British Museum. Scansores and Coccoyges, containing the families Rhamphastidæ, Galbulidæ, and Bucconidæ, by P. L. Sclater, and the families Indicatoridæ, Capitonidæ, Cuculidæ, and Musophagidæ, by G. E. Shelley. Cat. Birds Brit. Mus., vol. XIX, xii + 485 pp., XIII pls., text figs.
1892. Agassiz, Alexander. Reports on the dredging operations off the west coast of Central America to the Galapagos, to the west coast of Mexico, and in the Gulf of California, in charge of Alexander Agassiz, carried on by the U. S. Fish Commission Steamer "Albatross", Lieut. Commander Z. L. Tanner, U. S. N., commanding. II. General sketch of the expedition of the "Albatross", from

February to May, 1891. Bull. Mus. Comp. Zool., XXIII, no. 1, pp. 1-89, pls. I-XXII.

"This important work contains no special reference to birds, but excellent descriptions of the several islands are given besides other information of much interest in connection with the subject" (Ridgway). It was followed by a series of reports dealing with the various biological collections that were made.

1893. Ridgway, R. Remarks on the avian genus *Myiarchus*, with special reference to *M. yucatanensis* Lawrence. Proc. U. S. Nat. Mus., XVI, pp. 605-608.

Includes description of the genus *Eribates*, with the one species, *E. magnirostris*.

1893. Salvadori, Tommaso. Catalogue of the Columbæ, or pigeons, in the collection of the British Museum. Cat. Birds Brit. Mus., vol. XXI, xvii + 676 pp., XV pls.

1894. Lucas, Frederic Augustus. Notes on the anatomy and affinities of the Cœrebidæ and other American birds. Proc. U. S. Nat. Mus., XVII, pp. 299-312, 13 text figs.

1894. Ridgway, R. Descriptions of twenty-two new species of birds from the Galapagos Islands. Proc. U. S. Nat. Mus., XVII, pp. 357-370.

"The new species herein described were contained in the very large and valuable collection of Galapagos birds made by Dr. G. Baur and Mr. C. F. Adams, in 1891, which was referred to the author for determination of the species soon after the return of those gentlemen from their highly successful exploration of that remarkable island group. Many of the specimens having been collected on islands never before visited by a collector, the number of new species found among them was, as might be expected, unusually large. The new forms described are the following: (1) *Nesomimus bauri*, Tower Island, p. 357; (2) *Nesomimus bindloei*, Bindloe Island, p. 358; (3) *Nesomimus adamsi*, Chatham Island, p. 358; (4) *Certhidea salvini*, Indefatigable Island, p. 358; (5) *Certhidea bifasciata*, Barrington Island, p. 359; (6) *Certhidea mentalis*, Tower Island, p. 359; (7) *Certhidea albemarlei*, Albemarle Island, p. 360; (8) *Certhidea luteola*, Chatham Island, p. 360; (9) *Geospiza barringtoni*, Barrington Island, p. 361; (10) *Geospiza propinqua*, Tower Island, p. 361; (11) *Geospiza bauri*, James Island, p. 362; (12) *Geospiza albemarlei*, Albemarle Island, p. 362; (13) *Geospiza fratercula*, Abingdon Island, p. 363; (14) *Geospiza debilirostris*, James Island, p. 363; (15) *Geospiza acutirostris*, Tower Island, p. 363; (16) *Camarhynchus rostratus*, James Island, p. 363; (17) *Camarhynchus productus*, Albemarle Island, p. 364; (18) *Camarhynchus salvini*, Chatham Island, p. 364; (19) *Camarhynchus affinis*, Albemarle Island, p. 365; (20) *Pyrocephalus*

carolensis, Charles Island, p. 365; (21) *Pyrocephalus intercedens*, Indefatigable Island, p. 366; (22) *Pyrocephalus abingdoni*, Abingdon Island, p. 367.

"There are also critical remarks (p. 361) on the '*Cactorni*' of Indefatigable, Albemarle, and Jervis islands, which collectively were doubtfully identified with *Cactornis assimilis*, Gould, and *Pyrocephalus dubius*, Gould (pp. 368-370), to which the Chatham Island form is referred, and of which detailed descriptions and full synonymy are given" (Ridgway).

1894. Sharpe, R. B. Catalogue of the Fulicariæ (Rallidæ and Heliornithidæ) and Alectorides (Aramidæ, Eurypygidæ, Mesitidæ, Rhinocetidae, Gruidæ, Psophiidæ, and Otididæ) in the collection of the British Museum. Cat. Birds Brit. Mus., vol. XXIII, xiii + 353 pp., IX pls.

1894. Stone, Witmer. A revision of the genus *Anous*. Proc. Acad. Nat. Sci. Phila., pp. 115-118.

1895. Salvadori, T. Catalogue of the Chenomorphæ (Palamedææ, Phoenicopter, Anseres), Crypturi, and Ratitæ in the collection of the British Museum. Cat. Birds Brit. Mus., XVII, xv + 636 pp., XIX pls.

1895. Townsend, Charles Haskins. Birds from Cocos and Malpelo islands, with notes on petrels obtained at sea. = Reports on the dredging operations off the west coast of Central America to the Galapagos, to the west coast of Mexico, and in the Gulf of California, in charge of Alexander Agassiz, carried on by the U. S. Fish Commission Steamer "Albatross", during 1891, Lieut. Commander Z. L. Tanner, U. S. N., commanding. XVII. Bull. Mus. Comp. Zool., XXVII, 1895, pp. 121-126, 2 col. pls. (*Cocornis agassizi* and *Nesotriccus ridgwayi*).

"Three species of *Procellariidæ* from the Galapagos Archipelago are mentioned: *Oceanodroma cryptoleucura* (off Wenman Island), *Procellaria tethys* (off Chatham Island), and *Puffinus 'tenebrosus*, Pelz.,' = *P. subalaris*, Townsend, this paper, p. 650 (off Chatham and Wenman islands)" (Ridgway).

Cocornis agassizi (= *Pinaroloxias inornata*) and *Nesotriccus ridgwayi* are described as new species (and new genera) from Cocos Island.

1896. Ridgway, R. Preliminary description of some new birds from the Galapagos Archipelago. Proc. U. S. Nat. Mus., XVIII, pp. 293-294.

"These new forms are the result of further examination of specimens in Dr. Baur's collection as well as National Museum specimens collected by the naturalists of the *Albatross* in 1888 and 1891. They are as follows: (1) *Geospiza pachyrhyncha*, Tower Island, p. 293; (2) *Geospiza fatigata*, Indefatigable Island, p. 293; (3)

Camarhynchus bindloei, Bindloe Island, p. 294; (4) *Camarhynchus compressirostris*, Jervis Island, p. 294; (5) *Camarhynchus incertus*, James Island, p. 294" (Ridgway).

1896. Saunders, Howard, and Salvin, O. Catalogue of the Gaviæ and Tubinares in the collection of the British Museum. Gaviæ (terns, gulls, and skuas) by Howard Saunders. Tubinares (petrels and albatrosses) by Osbert Salvin. Cat. Birds Brit. Mus., vol. XXV, xv + 475 pp., VIII pls., text figs.

1896. Sharpe, R. B. Catalogue of the Limicolæ in the collection of the British Museum. Cat. Birds Brit. Mus., XXIV, xii + 794 pp., VII pls., text figs.

- 1897a. Baur, G. H. C. L. New observations on the origin of the Galapagos Islands, with remarks on the geological age of the Pacific Ocean. No. 1. Am. Nat., XXXI, pp. 661-680; No. II, *ibid.*, pp. 864-896 (incomplete).

A further elaboration of Dr. Baur's argument that the Galapagos Islands were at one time connected with the American continent (see Baur, 1891). The second part is marked "to be continued" but no further chapters follow. Dr. Baur's death occurred at about this time and presumably the paper was never finished. See part 1, p. 662, for a list of Baur's publications dealing with his theories regarding the origin of the Galapagos and their animal and plant life.

- 1897b. Baur, G. H. C. L. Birds of the Galapagos Archipelago: a criticism of Mr. Robert Ridgway's paper. Am. Nat., XXXI, pp. 777-784. [Not seen by me.]

1897. Ridgway, R. Birds of the Galapagos Archipelago. Proc. U. S. Nat. Mus., XIX, no. 1116, 1896 (March 15, 1897), pp. 459-670, pls. LVI-LVII, many figs. in text.

The outstanding treatise upon Galapagos birds, the introductory statement that it "is intended to embody practically all that is known of the avifauna of the Galapagos Archipelago" being abundantly justified. The new subject matter here presented is based chiefly upon collections made by "the naturalists of the *Albatross* in 1888 and 1891, and Messrs. Baur and Adams in 1891." Dr. Baur's collection eventually went to the Rothschild Museum, Tring, England. In the introduction there are discussions of the relations of the Galapagos species, lists of the genera upon the Galapagos and as compared with other regions, and lists of the species reported from each island. In the body of the paper, under each species are given synonymies, detailed descriptions, lists of specimens, in many cases line cuts of structural features, and maps showing distribution. A bibliography lists nearly all publications pertaining to the avifauna of the Gala-

pagos that had appeared up to that time, with illuminating comments and explanatory notes upon each one.

My personal copy of this publication is of interest. It is inscribed upon the cover (presumably in Dr. Baur's handwriting), "G. Baur. April 3rd 97 Chicago;" upon the first page (in Mr. Ridgway's handwriting), "March 30, 1897. Dr. G. Baur: with kind regards of Robert Ridgway." The text is interspersed with comments and alterations, some in pencil, some in red ink, inserted by Dr. Baur.

1898. Ogilvie-Grant, W. R. (See Sharpe, R. B.)

1898. Ridgway, R. Birds of the Galapagos Archipelago. Am. Nat., XXXII, pp. 386-389. Under "correspondence". Replying to criticisms of Dr. Baur.

- 1898a. Rothschild, Walter. [Descriptions of new species of birds from the Galapagos Islands.] Bull. Brit. Orn. Club, VII, no. LIV, May 25, pp. li-liii.

The following species named: *Phalacrocorax harrisi*, Narborough Island, p. lii; *Sula websteri*, "Clarion Island, Galapagos, and the neighboring seas," p. lii; *Nesomimus hulli*, Culpepper Island, p. liii; *Nesomimus affinis*, Narborough Island, p. liii; *Certhidea becki*, Wenman Island, p. liii; *Certhidea drownei*, Culpepper Island, p. liii.

- 1898b. Rothschild, W. [Description of a new species of *Nesomimus*.] Bull. Brit. Orn. Club, VIII, no. LVI, Oct. 31, p. vii.

Nesomimus carringtoni [typographical mistake for *barringtoni*], Barrington Island.

1898. Sharpe, R. B., and Ogilvie-Grant, William Robert. Catalogue of the Plataleæ, Herodiones, Steganopodes, Pygopodes, Alcæ, and Impennes in the collection of the British Museum. Plataleæ (Ibises and Spoonbills) and Herodiones (Hérons and Storks), by R. Bowdler Sharpe. Steganopodes (Cormorants, Gannets, Frigate-Birds, Tropic-Birds, and Pelicans), Pygopodes (Divers and Grebes), Alcæ (Auks), and Impennes (Penguins), by W. R. Ogilvie-Grant. Cat. Birds Brit. Mus., XXVI, xvii + 687 pp., VII pls., text figs.

1899. Rothschild, Walter, and Hartert, Ernst. A review of the ornithology of the Galapagos Islands. With notes on the Webster-Harris expedition. Novit. Zool., VI, pp. 85-205, pls. V-VI, many text figs.

A contribution of great importance, based upon "not less than 3075 skins from the recent expedition under Mr. Harris, and the Baur collection of about 1100 skins," besides which the authors "had constant access to Gould's and Salvin's types in the British Museum" (pp. 141-142). Introductory chapters include the diaries of some of the collectors, a brief list of publications, and "general

remarks about the fauna of the Galapagos Islands." New forms are described as follows: *Certhidea olivacea ridgwayi*, Charles Island, p. 149; *Geospiza darwini*, Culpepper Island, p. 158; *Geospiza dubia simillima*, Charles Island, p. 161; *Geospiza fuliginosa minor*, Bindloe and Abingdon islands, p. 162; *Geospiza scandens septentrionalis*, Wenman and Culpepper islands, p. 165; *Nesopelia galapagoensis exsul*, Wenman and Culpepper islands, p. 184; *Creciscus sharpei*, Indefatigable Island, p. 185.

1899. Sharpe, R. Bowdler. A hand-list of the genera and species of birds, vol. I, xxi + 303 + 20 pp.

The monotypic genus *Nannopterum*, confined to the Galapagos Archipelago, is here named (on p. 235).

1899. Wheeler, William Morton. George Baur's life and writings. Am. Nat., XXXIII, pp. 15-30, 1 text fig. (photo of Baur).

Includes a list of Dr. Baur's writings, which contains a number of important papers on the Galapagos Islands.

1901. Heller, Edmund, and Snodgrass, Robert Evans. Descriptions of Two New Species and Three New Subspecies of Birds From the Eastern Pacific, Collected by the Hopkins-Stanford Expedition to the Galapagos Islands. Condor, III, pp. 74-77.

New forms of Galapagos and Cocos islands birds described as follows: *Nesomimus melanotis dierythrus*, North Seymour Island, p. 74; *Geospiza scandens rothschildi*, Bindloe Island, p. 75; *Geospiza fortis platyrhyncha*, Iguana Cove, Albemarle Island, p. 75; *Micranous diamesus*, Cocos Island, p. 76.

1901. Ridgway, R. The birds of North and Middle America. U. S. Nat. Mus., Bull. 50, part 1, xxx + 715 pp., 20 pls.

The treatment of the Galapagos "finches" in this volume is practically a monograph of the systematic aspects of the genera *Platyspiza*, *Camarhynchus*, *Geospiza*, and *Cocornis* (= *Pinaroloxias*), including exhaustive synonymies of the species.

1901. Snodgrass, R. E., and Heller, E. A New Species of *Geospiza* Collected by the Hopkins-Stanford Expedition to the Galapagos Islands. Condor, III, p. 96.

Geospiza heliobates, Tagus Cove, Albemarle Island.

1902. Beck, Rollo Howard. The Wingless Cormorant of the Galapagos. Condor, IV, pp. 20-21, 2 text figs.

1902. Beck, R. H. A letter from the Galapagos expedition. Condor, IV, pp. 50-52.

1902. Beck, R. H. [Letter to the editor, written from Albemarle Island, Galapagos Archipelago.] Condor, IV, p. 99.

1902. Brewster, W. Birds of the Cape Region of Lower California. Bull. Mus. Comp. Zool., XLI, pp. 1-241, map.
1902. Gadow, Hans. The wings and the skeleton of *Phalacrocorax harrisi*. Novit. Zool., IX, pp. 169-176, pls. XIV-XV.
1902. Richmond, Charles Wallace. Note on *Pinaroloxias inornata* (Gould). Proc. Biol. Soc. Wash., XV, pp. 247-248.
 Demonstrating the fact that the recently named *Cocornis agassizii* Townsend (described from Cocos Island) is synonymous with *Cactornis inornata* Gould, mistakenly supposed to be from a Polynesian island.
1902. Ridgway, R. The birds of North and Middle America. U. S. Nat. Mus. Bull, 50, part II, xx + 834 pp., 22 pls.
- 1902a. Rothschild, W. [Nests and eggs of certain Galapagos birds.] Bull. Brit. Orn. Club, XII, Feb. 28, 1902, pp. 46-47.
 The species described are *Certhidea olivacea fusca*, *Geospiza fuliginosa*, *Pyrocephalus dubius*, and *Nesomimus adamsi*.
- 1902b. Rothschild, W. [Exhibition of and comments upon certain birds of Cocos and the Galapagos islands.] Bull. Brit. Orn. Club, XIII, Oct. 31, 1902, pp. 6-7.
 Includes the description of *Sula granti*, new species, from the Galapagos Islands.
1902. Rothschild, W., and Hartert, E. Further notes on the fauna of the Galapagos Islands. Notes on the birds. Novit. Zool., IX, 1902, pp. 381-481, pl. X (colored, of *Phalacrocorax harrisi*), 2 text figs.
 Largely devoted to life history, and containing descriptions of nests and eggs of many of the land birds. An "annotated list of the birds of the Galapagos Islands" (pp. 416-418) numbers 108 forms.
1902. Snodgrass, R. E., and Heller, E. The birds of Clipperton and Cocos Islands. = Papers from the Hopkins-Stanford Expedition, 1898-1899. XI. Proc. Wash. Acad. Sci., IV, pp. 501-520.
1902. Snodgrass, R. E. The relation of the food to the size and shape of the bill in the Galapagos genus *Geospiza*. Auk, XIX, pp. 367-381, pls. XI-XIII.
 The evidence seems to favor "the general conclusion that there is no correlation between the food and the size and shape of the bill."
1903. Bangs, Outram. Description of a New Race of the Great Blue Heron from the Galapagos Islands. Proc. New England Zool. Club, III, pp. 99-100. (Not seen.)
Ardea herodias cognata, new subspecies, Indefatigable Island.

1903. Snodgrass, R. E. Notes on the anatomy of *Geospiza*, *Cocornis*, and *Certhidia*. Auk, XX, pp. 402-417, pls. XVII-XX.

The conclusions reached are that there is close resemblance and probably near relationship between the three genera.

1904. Beck, R. H. Bird Life among the Galapagos Islands. Condor, VI, pp. 5-11, 6 figs.
1904. Ridgway, R. The birds of North and Middle America. U. S. Nat. Mus., Bull. 50, part III, xx + 801 pp., 19 pls.
1904. Snodgrass, R. E., and Heller, E. Papers from the Hopkins-Stanford Galapagos Expedition, 1898-1899. XVI. Birds. Proc. Wash. Acad. Sci., V, pp. 231-372.

A carefully prepared report upon a large collection of birds. Under many of the forms, more especially of the land birds peculiar to the Archipelago, there are elaborately detailed descriptions of plumages, tables of measurements, and life history notes, together with suggestive speculations regarding descent and relationship.

1906. Sharpe, R. Bowdler. Birds, in The history of the collections contained in the natural history departments of the British Museum. London: Printed by order of the trustees of the British Museum. Vol. II, pp. 79-515.

- 1907-1910. Godman, Frederick DuCane. A monograph of the petrels (Order Tubinares) by Frederick DuCane Godman. D.C.L. F.R.S. With hand-coloured plates by J. G. Keulemans. Witherby & Co. 326 High Holborn London. 1907-1910. Pp. lv + 381, 103 col. pls.

1907. Ridgway, R. The birds of North and Middle America. U. S. Nat. Mus., Bull. 50, part IV, xxii + 973 pp., 34 pls.

1907. Rothschild, W. Extinct birds. An attempt to unite in one volume a short account of those Birds which have become extinct in historical times—that is, within the last six or seven hundred years. To which are added a few which still exist, but are on the verge of extinction. By The Hon. Walter Rothschild, Ph. D., F. Z. S. With 45 Colored Plates, embracing 63 subjects, and other illustrations. London. Hutchinson & Co., Paternoster Row, E. C., 1907. Pp. xxix + 244.

Brief accounts of *Geospiza magnirostris* and *G. dentirostris*, supposedly extinct species, with a colored plate of *G. magnirostris* and of the head of *G. strenua*.

1909. Sharpe, R. B. A hand-list of the genera and species of birds. Vol. V. Pp. xx + 694.
1910. Carriker, M. A., Jr. An annotated list of the birds of Costa Rica including Cocos Island. Ann. Carnegie Mus., VI, pp. 314-915, 1 folding map.

1912. Mathews, Gregory M. The birds of Australia. Vol. II, part 1, pp. 1-120, pls. 68-81, May 30, 1912.
1912. Oberholser, Harry Church. A revision of the forms of the great blue heron (*Ardea herodias* Linnæus). Proc. U. S. Nat. Mus., vol. 43, pp. 531-559.
Ardea herodias cognata, from the Galapagos Islands.
1912. Streets, Thomas H. The Forked-tailed Gull (*Xema furcatum*). Auk, XXIX, pp. 233-234.
1913. Gifford, Edward Winslow. The birds of the Galapagos Islands, with observations on the birds of Cocos and Clipperton islands (Columbiformes to Pelecaniformes). Expedition of the California Academy of Sciences to the Galapagos Islands, 1905-1906. VIII. Proc. Calif. Acad. Sci., Fourth Ser., II, pt. I, pp. 1-132, pls. 1-7.
1914. Mathews, G. M. On the species and subspecies of the genus *Fregata*. Austral Avian Record, II, Dec. 19, pp. 117-121.
Includes descriptions of *Fregata minor magnificens* ("Barrington, Indefatigable, Albemarle Islands, etc.") and *F. m. ridgwayi* ("breeds on Culpepper and Wenman Islands.").
1914. Nichols, J. T. An undescribed race of *Oceanodroma castro*. Auk, XXXI, pp. 388-390, figs.
Oceanodroma castro bangsi.
1914. Ridgway, R. The birds of North and Middle America. U. S. Nat. Mus., Bull. 50, part VI, xx + 882 pp., 36 pls.
1915. Bangs, Outram. The American forms of *Gallinula chloropus* (Linn.). Proc. New England Zool. Club, V, May 17, pp. 93-99.
- 1915a. Rothschild, W. [Notes on the genus *Sula*.] Bull. Brit. Orn. Club, XXXV, Jan. 27, pp. 41-45.
- 1915b. Rothschild, W. On the genus *Fregata*. Novit. Zool., XXII, Feb. 12, pp. 145-146.
1915. Shufeldt, Robert W. Comparative Osteology of Harris's Flightless Cormorant (*Nannopterum harrisi*). Emu, XV, pp. 86-114, pls. XV-XIX.
1916. Ridgway, R. The birds of North and Middle America. U. S. Nat. Mus., Bull. 50, part VII, xiii + 543 pp., 24 pls.
1917. Chapman, Frank M. The distribution of bird-life in Colombia; a contribution to the biological survey of South America. Bull. Am. Mus. Nat. Hist., XXXVI, x + 729 pp., 41 pls., 21 text figs.
1918. Bangs, O. Notes on the Species and Subspecies of *Pacilonitta* Eyton. Proc. New England Zool. Club, VI, pp. 87-89. (Not seen by me.)

1918. Cory, Charles Barney. Catalogue of birds of the Americas and the adjacent islands in Field Museum of Natural History. Field Mus. Nat. Hist., publ. 197, Zool. Ser. vol. XIII, pt. II, no. 1, pp. 1-315, pl. 1.
1918. Loomis, Leverett Mills. A review of the albatrosses, petrels, and diving petrels. Expedition of the California Academy of Sciences to the Galapagos Islands, 1905-1906. XII. Proc. Calif. Acad. Sci., Fourth Ser., II, pt. II, pp. 1-187, pls. 1-17.
- Part VI ("Remarks on the species of the Pacific Ocean adjacent to North America and the Galapagos Islands"), comprising the greater part of the publication, "is based primarily upon the results of the Expedition of the California Academy of Sciences to the Galapagos Islands during 1905 and 1906."
1919. Cory, C. B. Catalogue of birds of the Americas and the adjacent islands in Field Museum of Natural History. Field Mus. Nat. Hist., Publ. 203, Zool. Ser. vol. XIII, pt. II, pp. 317-607, pl. 2.
1919. Gifford, E. W. Field Notes on the land birds of the Galapagos Islands and of Cocos Island, Costa Rica. Expedition of the California Academy of Sciences to the Galapagos Islands, 1905-1906. XIII. Proc. Calif. Acad. Sci., Fourth Ser., II, pt. II, pp. 189-258.
- 1919-1927. Hartert, E. Types of birds in the Tring Museum. B. Types in the general collection. Novit. Zool., XXVI, 1919, pp. 123-178; XXVII, 1920, pp. 425-505; XXIX, 1922, pp. 365-412; XXXII, 1925, pp. 259-276; XXXIII, 1926, pp. 344-357; XXXIV, 1927, pp. 1-30.
1919. Loomis, L. M. Variation in the Galapagos Albatross. Auk, XXXVI, pp. 370-372, pls. XIV-XVI.
1919. Ridgway, R. The birds of North and Middle America. U. S. Nat. Mus., Bull. 50, part VIII, xvi + 852 pp., 34 pls.
1921. Lowe, Percy R. [Description of a new petrel from the Galapagos Islands.] Bull. Brit. Orn. Club, XLI, July 5, 1921, p. 140.
- Oceanites gracilis galapagoensis*, Charles Island.
1923. Phillips, John C. A natural history of the ducks. Vol. II, 1923 (Houghton Mifflin Company) vii + 409 pp., pls. 19-44, maps 28-65.
1924. Beebe, William. Galapagos: Worlds End. J. P. Putnam's Sons, New York and London, The Knickerbocker Press, 443 pp., 24 colored illustrations, 83 photographs, and maps.
- Contains passing and disconnected bits of information (often of great interest) regarding various species

of birds; also a number of illustrations. A map (fig. 13, opp. p. 72) figures distribution of *Nesomimus*.

1924. Lowe, Percy R. Some notes on the *Fregatidae*. Novit. Zool., XXXI, Oct. 30, pp. 299-313, pls. XXII, XXIII.
Includes critical comments upon the Galapagos species.
1925. Mathews, Gregory M. The Birds of Australia. Bibliography of the birds of Australia, part 1. Pp. viii + 96, one pl. April 6, 1925.
1925. Murphy, Robert Cushman. Notes on certain species and races of oyster-catchers. American Museum Novitates, no. 194, Nov. 17, pp. 1-15.
Comments upon *Hamatopus palliatus galapagensis*.
1926. Beebe, W. The Arcturus Adventure, An Account of the New York Zoological Society's First Oceanographic Expedition. G. P. Putnam's Sons. New York and London, The Knickerbocker Press, 439 pp., "with 77 illustrations from colored plates, photographs and maps."
Chapter IV is devoted to the albatross colony on Hood Island. Appendix A (pp. 427-430) contains a list of the birds of Osborn Island (between Hood and Gardner).
1926. Chapman, Frank M. The distribution of bird-life in Ecuador; a contribution to the study of the origin of Andean bird-life. Bull. Am. Mus. Nat. Hist., LV, xiii + 784 pp., 30 pls., 20 text figs.
1926. Swann, H. Kirke. A monograph of the birds of prey (order Accipitres). Part V, Jan. 25, pp. 277-364, 5 pls.
1927. Gyldenstolpe, Nils. Types of Birds in the Royal Natural History Museum in Stockholm. Arkiv för Zoologi utgivet av K. Svenska Vetenskapsakademien. Band 19, häfte 1, pp. 1-116.
Dendroica petechia galapagensis (p. 30) and *Spheniscus mendiculus* (p. 106).
1927. Hellmayr, Charles Edward. Catalogue of birds of the Americas and the adjacent islands in Field Museum of Natural History. Field Mus. Nat. Hist., Publ. 242, Zool. Ser. XIII, pt. V, pp. vi + 517.
1927. Peters, James Lee. A revision of the golden warblers, *Dendroica petechia* (Linné). Proc. Biol. Soc. Wash., vol. 40, pp. 31-42.
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INDEX

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- ahingdoni (Cactornis), see *Geospiza scandens* ahingdoni
 (*Geospiza*), see *Geospiza*
 (*Geospiza scandens*), see *Geospiza*
 (*Pyrocephalus*), see *P. nanus nanus*
 (*Pyrocephalus nanus*), see *P. nanus nanus*
Actitis macularia, 61
acutirostris (*Geospiza*), see *Geospiza*
 (*Geospiza fuliginosa*), see *Geospiza*
adamsi (*Nesomimus*), see *N. melanotis*
Agialeus semipalmatus, 58
Agialitis semipalmata, 58
Astelata phaopygia, 34
athereus (*Phaethon*), see *Phaethon*
 Phaeton, see *Phaethon*
affinis (*Camarhynchus*), see *Camarhynchus*
 (*Geospiza*), see *Camarhynchus*
 (*Geospiza psittacula*), see *Camarhynchus*
 (*Nesomimus*), see *N. parvulus parvulus*
 (*Nesomimus parvulus*), see *N. p. parvulus*
agassizi (*Cocornis*), see *Pinaroloxia inornata*
alba (*Calidris*), see *Crocethia*
 (*Crocethia*), see *Crocethia*
 (*Gygis*), see *Gygis*
albemarlei (*Certhidea*), see *Certhidea olivacea*
 (*Geospiza*), see *Geospiza fortis*
 (*Geospiza dubia*), see *Geospiza fortis*
albinucha (*Querquedula discors*), see *Q. discors*
Anas bahamensis, 45
 galapagensis, 46
 maculirostris, 46
Anous galapagensis, 66
 stolidus, 66
 stolidus galapagensis, 66
aquila (*Fregata*), see *F. magnificens* and *F. minor ridgwayi*
aquilus (*Tachypetes*), see *Fregata magnificens* and *F. minor ridgwayi*
Ardea herodias, 41
 herodias cognata, 41
 plumbea, 42
 sundevalli, 42
 violacea, 43
arenaria (*Calidris*), see *Crocethia alba*
Arenaria interpres interpres, 59
Asio galapagensis, 80
 galapagoensis, 80
assimilis (*Cactornis*), see *Cactornis*
aureola (*Dendroica*), see *Dendroica petechia aureola*
 (*Dendroica*), see *D. petechia aureola*
 (*Dendroica petechia*), see *Dendroica*
 (*Sylvicola*), see *Dendroica petechia aureola*
aureus (*Camarhynchus*), see *Camarhynchus*
bahamensis (*Anas*), see *Paeilonitta galapagensis*
 (*Dasila*), see *Paeilonitta galapagensis*
 (*Paeilonetta*), see *Paeilonitta galapagensis*
 (*Paeilonitta*), see *P. galapagensis*
bairdi (*Heteropygia*), see *Pisobia*
bairdii (*Pisobia*), see *Pisobia*
 (*Tringa*), see *Pisobia*
bangsi (*Oceanodroma castro*), see *O. castro*
barringtoni (*Geospiza*), see *G. scandens intermedia*
 (*Nesomimus*), see *Nesomimus*
 (*Nesomimus melanotis*), see *Nesomimus parvulus*
 (*Nesomimus parvulus*), see *Nesomimus*
bauri (*Geospiza*), see *Geospiza fortis*
 (*Nesomimus*), see *Nesomimus*
 (*Nesomimus parvulus*), see *Nesomimus*
 (*Nesomimus personatus*), see *Nesomimus parvulus*
becki (*Certhidea*), see *Certhidea*
 (*Certhidea olivacea*), see *Certhidea*
 (*Puffinus*), see *P. obscurus subalaris*
bifasciata (*Certhidea*), see *Certhidea*
 (*Certhidea cinerascens*), see *Certhidea*
bindloeii (*Camarhynchus*), see *Camarhynchus habeli*
 (*Nesomimus*), see *Nesomimus parvulus*
 (*Nesomimus melanotis*), see *Nesomimus parvulus*
 (*Nesomimus parvulus*), see *Nesomimus*
 (*Nesomimus personatus*), see *Nesomimus parvulus*
Blasipus fuliginosus, 64
borealis (*Numenius*), see *N. hudsonicus*

- brevipes (Totanus), see *Heteroscelus in-*
canus
 brevirostris (Cactornis), see *Geospiza*
fortis
 brewsteri (Sula), see *S. nebouxii*
Buteo, 15
 galapagensis, 46
 galapagoensis, 46
 infulatus, 50
 leucops, 50
 poliosoma poecilochrous, 50
 poliosoma poliosoma, 50
Butorides javanicus, 42
 plumbeus, 42
 sundevalli, 29, 42
cachinnans (*Gallinula chloropus*), see *Gal-*
linula
Cactornis, 141
 abingdoni, 195
 assimilis, 198
 brevirostris, 16, 152, 154, 161
 hypoleuca, 240, 242
 inornata, 268
 pallida, 240, 241
 pallidus, 240
 scandens, 141, 190, 193
Cactospiza, 17, 18, 22, 25, 137, 140, 240
 giffordi, 241, 246, 248, 249
 heliobates, 241, 246, 247, 248, 249
 pallida, 25, 29
 pallida pallida, 240, 241, 243, 248, 249
 pallida producta, 241, 243, 248, 249
 pallida striatipecta, 241, 243, 245, 248,
 249
Calidris alba, 60
 arenaria, 60
californicus (*Pelecanus*), see *P. occiden-*
talis
 (*Pelecanus fuscus*), see *P. occidentalis*
Camarhynchus, 17, 18, 22, 24, 25, 27, 137,
 140, 215
 affinis, 219, 221, 222, 227, 228
 aureus, 236, 237, 239, 251
 bindloeii, 219, 220
 compressirostris, 215, 216
 conjunctus, 237, 239, 251
 crassirostris, 11, 208
 habeli, 22, 23, 219, 221, 227, 228
 incertus, 222
 pallidus, 240, 243
 parvulus, 21, 29
 parvulus parvulus, 22, 225, 229, 230, 234,
 235, 251
 parvulus salvini, 23, 230, 232, 234, 235
 pauper, 21, 24, 221, 224, 225, 227, 228
 productus, 243, 244
 prothemelas, 229, 232
 psittacula, 21, 215, 217, 219, 227, 228
 psittaculus, 23, 215
 rostratus, 215
 salvini, 232
 townsendi, 215
 variegatus, 208
candida (*Gygis alba*), see *G. alba*
carolensis (*Pyrocephalus*), see *P. nanus*
 nanus
carolinensis (*Pandion haliaëtus*), see
 Pandion
carringtoni (*Nesomimus*), see *N. parvulus*
 barringtoni
carringtoni (*Nesomimus melanotis*), see
 N. parvulus barringtoni
Casmerodius egretta, 15, 42
castro (*Oceanodroma*), see *Oceanodroma*
Catoptrophorus semipalmatus inornatus,
 60
Certhidea, 17, 18, 22, 27, 29, 137, 140, 250
 albemarlei, 254
 becki, 253, 259, 266, 267
 bifasciata, 253, 265, 266, 267
 cinerascens, 253, 261, 265, 266, 267
 cinerascens bifasciata, 265
 cinerascens cinerascens, 264
 drownei, 259
 fusca, 253, 257, 266, 267
 luteola, 263, 266, 267
 mentalis, 253, 260, 266, 267
 olivacea, 250, 251, 253, 254, 258, 260, 261,
 263, 266, 267
 olivacea becki, 259
 olivacea drownei, 259
 olivacea fusca, 257
 olivacea luteola, 253, 263
 olivacea mentalis, 259, 260
 olivacea olivacea, 254
 olivacea ridgwayi, 253, 261
 olivascens, 264
 ridgwayi, 251, 261, 266, 267
 salvini, 254
Charadrius semipalmatus, 58
Chroicocephalus franklinii, 65
cinerascens (*Certhidea*), see *Certhidea*
cinnamomea (*Tringa solitaria*), see *Tringa*
 solitaria
Coccyzus ferrugineus, 73
 melacoryphus, 15, 70
 melanocoryphus, 70

- Cocornis*, 268
agassizi, 268
cognata (*Ardea herodias*), see *Ardea*
Columba galapagensis, 67
compressirostris (*Camarhynchus*), see *Camarhynchus psittacula*
concolor (*Hirundo*), see *Progne modesta* (*Progne*), see *P. modesta*
conirostris (*Geospiza*), see *Geospiza* (*Geospiza conirostris*), see *Geospiza*
conjunctus (*Camarhynchus*), see *Camarhynchus*
Coprotheres pomarinus, 64
coronata (*Muscicapa*), see *Muscicapa*
crassirostris (*Camarhynchus*), see *Platyspiza* (*Platyspiza*), see *Platyspiza*
Craxirex galapagoensis, 46
Creagrus furcatus, 65
Creciscus sharpei, 52
sylonotus, 52
crissalis (*Sterna fuscata*), see *Sterna*
Crocethia alba, 60
cryptoleucura (*Oceanodroma*), see *O. castro*
cyanops (*Dysporus*), see *Sula dactylatra granti* (*Sula*), see *S. dactylatra granti*
Dafila bahamensis, 45
darwini (*Geospiza*), see *G. magnirostris* (*Geospiza conirostris*), see *G. magnirostris*
debilirostris (*Geospiza*), see *Geospiza*
Dendroica aureola, 132
petechia, 132
petechia galapagensis, 132
Dendroica aureola, 132
petechia, 15
petechia aureola, 132, 134, 135
dentirostris (*Geospiza*), see *Geospiza fortis*
derythrus (*Nesomimus*), see *N. parvulus parvulus* (*Nesomimus melanotis*), see *N. parvulus parvulus*
difficilis (*Geospiza*), see *Geospiza* (*Geospiza fuliginosa*), see *Geospiza*
Diomedea exulans, 33
irrorata, 33
nigripes, 33
discors (*Querquedula*), see *Querquedula*
Dolichonyx oryzivorus, 136
drowni (*Certhidea*), see *Certhidea becki* (*Certhidea olivacea*), see *Certhidea becki*
dubia (*Geospiza*), see *Geospiza fortis* (*Geospiza fortis*), see *Geospiza fortis*
dubius (*Pyrocephalus*), see *Pyrocephalus* (*Pyrocephalus rubinus*), see *Pyrocephalus*
Dysporus cyanops, 37
leucogaster, 38
egretta (*Casmerodius*), see *Casmerodius* (*Herodias*), see *Casmerodius*
Eribates, 15
Eribates magnirostris, 84
exsul (*Nesopelia galapagoensis*), see *Nesopelia*
exulans (*Diomedea*), see *D. irrorata*
erythrogaster (*Hirundo*), see *Hirundo*
erythrogastra (*Hirunda rustica*), see *H. erythrogaster*
fatigata (*Geospiza*), see *Geospiza scandens intermedia* (*Geospiza scandens*), see *Geospiza scandens intermedia*
ferrugineus (*Coccyzus*), see *Coccyzus*
fortis (*Geospiza*), see *Geospiza*
franklinii (*Chroicocephalus*), see *Larus pipixcan* (*Larus*), see *L. pipixcan*
fratercula (*Geospiza*), see *Geospiza fortis* (*Geospiza fortis*), see *Geospiza fortis*
frazari (*Haematopus palliatus*), see *Haematopus*
Fregata aquila, 38, 39
aquila minor, 39
magnificens, 38
minor magnificens, 39
minor ridgwayi, 39
fuliginosa (*Geospiza*), see *Geospiza* (*Geospiza fuliginosa*), see *Geospiza* (*Sterna*), see *S. fuscata crissalis*
fuliginosus (*Blasipus*), see *Larus* (*Larus*), see *Larus* (*Totanus*), see *Heteroscelus incanus*
furcata (*Xema*), see *Creagrus furcatus*
furcatus (*Xema*), see *Creagrus furcatus* (*Creagrus*), see *Creagrus* (*Larus*), see *Creagrus*
fusca (*Certhidea*), see *Certhidea* (*Certhidea olivacea*), see *Certhidea*
fuscus (*Pelecanus*), see *P. occidentalis*
galapagensis (*Anas*), see *Pacilonitta* (*Anous*), see *Anous*

- (Anous stolidus), see Anous
 (Asio), see A. galapagoensis
 (Buteo), see B. galapagoensis
 (Columba), see Nesopelia galapagoensis
 (Haematopus), see Haematopus
 (Haematopus palliatus), see Haematopus
 (Pæcilonitta), see Pæcilonitta
 (Pæcilonetta), see Pæcilonitta
 (Pæcilonetta bahamensis), see Pæcilonetta galapagensis
 (Zenaida), see Nesopelia galapagoensis
 galapagoensis (Asio), see Asio
 (Buteo), see Buteo
 (Craxirex), see Buteo
 (Nesopelia galapagoensis), see Nesopelia
 (Oceanites gracilis), see Oceanites
 (Otus), see Asio
 (Polyborus), see Buteo
 (Porzana), see Creciscus spilonotus
 (Zenaida), see Nesopelia
 galeata (Gallinula), see G. chloropus
 cachinnans
 gallapagensis (Dendroica petechia), see
 Dendroica petechia aureola
 (Nesopelia), see Nesopelia galapagoensis
 Gallinula chloropus cachinnans, 15, 57
 galeata, 57
 Geospiza, 17, 18, 24, 27, 137, 140, 141
 abingdoni, 195
 acutirostris, 23, 24, 177, 186, 187
 affinis, 222
 albemarleii, 152, 153, 157
 barringtoni, 193
 bauri, 152, 153, 161
 conirostris, 22, 25, 142, 201
 conirostris conirostris, 201, 206, 207
 conirostris darwini, 142
 conirostris propinqua, 201, 204, 206, 207
 crassirostris, 208
 darwini, 142
 debilirostris, 18, 24, 177, 180, 186, 187
 denti-rostris, 16, 152, 153, 161, 162, 178
 difficilis, 22, 177, 178, 186, 187
 dubia, 152, 155
 dubia albemarleii, 152
 dubia simillima, 152, 153, 161
 fatigata, 193
 fortis, 16, 18, 21, 22, 23, 25, 152, 153, 155,
 176
 fortis dubia, 152
 fortis fratercula, 152
 fortis platyrhyncha, 152, 153
 fortis simillima, 152
 fratercula, 21, 152, 153, 161
 fuliginosa, 18, 22, 23, 25, 169
 fuliginosa acutirostris, 177
 fuliginosa difficilis, 178
 fuliginosa fuliginosa, 169, 170, 172, 176
 fuliginosa minor, 22, 23, 170, 172, 173,
 176
 fuliginosa parvula, 169
 habeli, 219
 harterti, 169
 heliobates, 247
 incerta, 222
 intermedia, 193
 magnirostris, 11, 21, 22, 23, 25, 141, 176
 media, 201
 minor, 173
 nebuloza, 152, 153, 161
 pachyrhyncha, 141
 pallida, 240, 243
 parvula, 169, 173, 229
 paupera, 224
 platyrhyncha, 152, 157
 propinqua, 204
 prothemelas, 229
 prothemelas salvini, 232
 psittacula affinis, 222
 psittacula psittacula, 215
 psittacula townsendi, 215
 rothschildi, 197
 salvini, 232
 scandens, 22, 23, 188, 190
 scandens abingdoni, 22, 189, 195, 196,
 197, 199, 200
 scandens fatigata, 193
 scandens intermedia, 29, 189, 192, 193,
 199, 200
 scandens rothschildi, 23, 189, 196, 197,
 199, 200
 scandens scandens, 189, 190, 192, 199,
 200
 scandens septentrionalis, 184
 septentrionalis nigrescens, 177, 185, 186,
 187
 septentrionalis septentrionalis, 177, 184,
 186, 187
 simillima, 152
 strenua, 141
 Geospizidae, 137, 139, 140

- giffordi (Cactospiza), see Cactospiza
 glyphorhynchus (Phoenicopterus), see P. ruber
 gossi (Sula), see S. nebouxii
 gracilis (Oceanites), see O. g. galapagoensis
 granti (Sula), see S. dactylatra granti (Sula dactylactra), see Sula
 Guiraca, 27
 Gygis alba, 66
 alba candida, 66
 habeli (Camarhynchus), see Camarhynchus
 (Geospiza), see Camarhynchus
 Haematopus galapagensis, 57
 palliatu8, 57
 palliatu8 frazari, 58
 palliatu8 galapagensis, 57
 haliaëtus (Pandion), see P. h. carolinensis
 harrisi (Nannopterum), see Nannopterum (Phalacrocorax), see Nannopterum
 harterti (Geospiza), see Geospiza f. fuliginosa
 heliobates (Cactospiza), see Cactospiza (Geospiza), see Cactospiza
 Helodromas solitarius, 60
 helvetica (Squatarola), see S. squatarola
 herodias (Ardea), see A. h. cognata
 Herodias egretta, 42
 Heteractitis incanus, 61
 Heteropygia bairdi, 59
 Heteroscelus incanus, 61
 Hiaticula semipalmata, 58
 Himantopus mexicanus, 15, 62
 nigricollis, 62
 Hirundo concolor, 102
 erythrogaster, 104
 modesta, 102
 rustica erythrogastra, 104
 hudsonicus (Numenius), see Numenius (Phæopus), see Numenius
 hulli (Nesomimus), see Nesomimus (Nesomimus melanotis), see Nesomimus (Nesomimus parvulus), see Nesomimus (Nesomimus personatus), see Nesomimus
 humboldtii, Spheniscus, see S. mendiculus
 hyperboreus (Phalaropus), see Lobipes lobatus
 hypoleuca (Cactornis), see Cactospiza p. pallida
 incanus (Heteractitis), see Heteroscelus (Heteroscelus), see Heteroscelus
 incerta (Geospiza), see Camarhynchus affinis
 incertus (Camarhynchus), see C. affinis
 infulatus (Buteo), see Buteo
 inornata (Loxops), see Pinaroloxias (Pinaroloxias), see Pinaroloxias (Cactornis), see Pinaroloxias
 inornatus (Catoptrophorus semipalmatus), see Catoptrophorus
 intercedens (Pyrocephalus), see Pyrocephalus
 (Pyrocephalus nanus), see Pyrocephalus
 intermedia (Geospiza), see G. scandens intermedia
 (Geospiza scandens), see Geospiza
 interpres (Arenaria interpres), see Arenaria
 (Strepsilas), see Arenaria
 irrorata, Diomedea, see Diomedea
 javanicus (Butorides), see B. sundevalli
 Larus franklinii, 65
 fuliginosus, 64
 furcatus, 65
 pipixcan, 65
 leucogaster (Dysporus), see Sula nebouxii (Sula), see S. nebouxii
 leucops (Buteo), see Buteo
 limatus (Phaëthon æthereus), see P. æthereus
 Limonites minutilla, 59
 lobatus (Lobipes), see Lobipes (Phalaropus), see Lobipes
 Lobipes lobatus, 64
 Loxops inornata, 268
 luteola (Certhidea), see Certhidea (Certhidea olivacea), see Certhidea
 macdonaldi (Nesomimus), see Nesomimus
 niacularia (Actitis), see Actitis
 macularius (Tringoides), see Actitis
 maculirostris (Anas), see Querquedula versicolor
 magnificens (Fregata), see Fregata (Fregata minor), see F. magnificens
 magnirostris (Eribates), see Myiarchus (Geospiza), see Geospiza (Myiarchus), see Myiarchus (Myiobius), see Myiarchus
 media (Geospiza), see Geospiza c. conirostris
 Megalopterus stolidus, 66
 melacoryphus (Coccyzus), see Coccyzus

- melanocoryphus* (Coccyzus), see *Coccyzus melanocoryphus*
melanotis (Mimus), see *Nesomimus* (*Nesomimus*), see *Nesomimus* (*Orpheus*), see *Nesomimus*
mediculus (Spheniscus), see *Spheniscus mentalis* (Certhidea), see *Certhidea* (*Certhidea olivacea*), see *Certhidea*
mexicanus (Himantopus), see *Himantopus*
Mimus melanotis, 118, 121, 126
parvulus, 121
trifasciatus, 114
minimus (Pyrocephalus), see *P. dubius*
minor (Fregata aquila), see *F. minor* *ridgwayi* (*Geospiza*), see *G. fuliginosa minor* (*Geospiza fuliginosa*), see *Geospiza*
minutilla (Limonites), see *Pisobia* (*Pelidna*), see *Pisobia* (*Pisobia*), see *Pisobia* (*Tringa*), see *Pisobia*
modesta (Hirundo), see *Progne* (*Progne*), see *Progne*
Muscicapa coronata, 88
rubinus, 88
Myiarchus magnirostris, 29, 84
Myiobius magnirostris, 84
Nannopterum, 15, 38
harrisi, 38
nanus (Pyrocephalus nanus), see *Pyrocephalus* (*Pyrocephalus rubinus*), see *Pyrocephalus*
neboxii (Sula), see *Sula*
nebulosa (Geospiza), see *Geospiza fortis*
Neorhynchus, 27
Nesomimus, 15, 28, 29, 104, 111
adamsi, 104, 105, 119
affinis, 105, 121
barringtoni, 125, 129
bauri, 131
bindloeii, 126
carringtoni, 125
dierythrus, 121
hulli, 130
macdonaldi, 104, 105, 107, 109, 111, 115, 116, 117
melanotis, 104, 105, 107, 111, 115, 116, 118, 121, 125, 126, 128, 129, 130, 131
melanotis barringtoni, 125, 129
melanotis bindloeii, 126
melanotis carringtoni, 125
melanotis dierythrus, 105, 121
melanotis hulli, 130
melanotis melanotis, 121, 126, 129
melanotis parvulus, 121
melanotis personatus, 128
parvulus, 105, 121
parvulus affinis, 105, 121
parvulus barringtoni, 105, 111, 122, 124, 125
parvulus bauri, 105, 111, 122, 124, 131
parvulus bindloeii, 105, 111, 122, 126, 127
parvulus hulli, 105, 111, 122, 130
parvulus parvulus, 105, 111, 120, 122, 124
parvulus personatus, 105, 111, 122, 127, 128
parvulus wenmani, 105, 111, 122, 129, 130
personatus, 105, 128
personatus bauri, 131
personatus bindloeii, 126
personatus hulli, 130
personatus personatus, 128
trifasciatus, 104, 105, 107, 111, 114
Nesopelia, 67
galapagoensis, 67
galapagoensis exsul, 67
galapagoensis galapagoensis, 67
gallopaguensis, 67
Nesotriccus, 100
ridgwayi, 86, 100
nigrescens (*Geospiza septentrionalis*), see *Geospiza*
nigricollis (Himantopus), see *H. mexicanus*
nigripes (Diomedea), see *D. irrorata*
Numenius borealis, 61
hudsonicus, 61
Nyctanassa pauper, 43
violacea, 43
violacea pauper, 43
violacea paupera, 43
Nycticorax pauper, 43
violaceus, 43
obscurus (Puffinus), see *P. o. subalaris*
occidentalis (Pelecanus), see *Pelecanus*
Oceanites gracilis, 36
gracilis galapagoensis, 36
Oceanodroma castro, 35
castro bangsi, 35
cryptoleucura, 35
tethys, 35
Oestrelata phaeopygia, 34
olivacea (Certhidea), see *Certhidea*
Orpheus melanotis, 104, 118
parvulus, 120, 121
trifasciatus, 114

- Ortygometra spilonota*, 52
oryzivorus (*Dolichonyx*), see *Dolichonyx*
Otus galapagoensis, 80
pachyrhyncha (*Geospiza*), see *G. magnirostris*
Pæcilonitta bahamensis, 45
galapagensis, 45, 46
*palliatu*s (*Haematopus*), see *H. palliatu*s
galapagensis
pallida (*Cactornis*), see *Cactospiza*
(Cactospiza pallida), see *Cactospiza*
(Geospiza), see *Cactospiza*
pallidus (*Camarhynchus*), see *Cactospiza*
p. pallida
Pandion haliaëtus, 52
haliaëtus carolinensis, 52
parvirostris (*Pyrocephalus*), see *Pyrocephalus*
parvula (*Geospiza*), see *Camarhynchus p. parvulus*
(Geospiza fuliginosa), see *G. fuliginosa*
parvulus (*Camarhynchus parvulus*), see *Camarhynchus*
(Mimus), see *Nesomimus*
(Nesomimus melanotis), see *Nesomimus*
(Nesomimus parvulus), see *Nesomimus*
(Orpheus), see *Nesomimus*
pauper (*Camarhynchus*), see *Camarhynchus*
pauper
(Nyctanassa), see *N. violacea pauper*
(Nyctanassa violacea), see *Nyctanassa*
(Nycticorax), see *Nyctanassa violacea pauper*
paupera (*Geospiza*), see *Camarhynchus pauper*
(Nyctanassa violacea), see *N. v. pauper*
Pelecanus californicus, 36
fuscus, 36
fuscus californicus, 36
occidentalis, 15, 36
Pelidna minutilla, 59
personatus (*Nesomimus*), see *Nesomimus*
(Nesomimus melanotis), see *Nesomimus*
(Nesomimus parvulus), see *Nesomimus*
petechia (*Dendroica*), see *Dendroica petechia aureola*
(Dendroica), see *Dendroica petechia aureola*
Phæopus hudsonicus, 61
phæopygia (*Æstrelata*), see *Pterodroma*
(Æstrelata), see *Pterodroma*
(Pterodroma), see *Pterodroma*
Phaëthon æthereus, 36
æthereus limatus, 36
Phaëton æthereus, 36
Phalacrocorax harrisi, 38
Phalaropus hyperboreus, 64
lobatus, 64
Phoenicopterus glyphorhynchus, 45
ruber, 45
Pinaroloxias, 16, 27, 137, 140, 268
inornata, 14, 268, 269, 271
pipixcan (*Larus*), see *Larus*
piscator (*Sula*), see *S. piscator websteri*
piscatrix (*Sula*), see *S. piscator websteri*
Pisobia bairdii, 59
minutilla, 59
platyrhyncha (*Geospiza*), see *Geospiza fortis*
(Geospiza fortis), see *Geospiza fortis*
Platyspiza, 17, 22, 24, 137, 140, 208
crassirostris, 18, 22, 23, 208, 210, 211, 213, 214
plumbea (*Ardea*), see *Butorides sundevalli*
plumbeus (*Butorides*), see *B. sundevalli*
pœcilochrous (*Buteo poliosoma*), see *Buteo*
Pæcilonetta bahamensis, 45
bahamensis galapagensis, 46
galapagensis, 45
poliosoma (*Buteo poliosoma*), see *Buteo*
Polyborus galapagoensis, 46
pomarinus (*Coprotheres*), see *Stercorarius*
(Stercorarius), see *Stercorarius*
pomatrhinus (*Stercorarius*), see *S. pomarinus*
Perzana galapagoensis, 52
sharpei, 52
spilonota, 52
Procellaria tethys, 35
producta (*Cactospiza pallida*), see *Cactospiza*
productus (*Camarhynchus*), see *Cactospiza pallida producta*
Progne, 15
Progne concolor, 102
modesta, 102
propinqua (*Geospiza*), see *G. conirostris propinqua*
(Geospiza conirostris), see *Geospiza*
prothemelas (*Camarhynchus*), see *Camarhynchus parvulus*
(Geospiza), see *Camarhynchus parvulus*

- psittacula (Camarhynchus), see Camarhynchus
 psittaculus (Camarhynchus), see C. psittacula
 Pterodroma phaeopygia, 34
 Puffinus lherminieri becki, 34
 lherminieri subalaris, 34
 obscurus, 34
 obscurus subalaris, 34
 subalaris, 34
 tenebrosus, 34
 punctatissima (Strix), see Tyto (Tyto), see Tyto
 Pyrocephalus, 15, 28, 29, 88
 abingdoni, 88
 carolensis, 88
 dubius, 91, 96, 99
 intercedens, 93
 minimus, 96
 nanus abingdoni, 88
 nanus intercedens, 91, 93, 99
 nanus nanus, 88, 93, 99
 parvirostris, 88
 rubinus dubius, 96
 rubinus nanus, 88, 93
 Querquedula discors, 45
 discors albinucha, 45
 versicolor, 46
 ridgwayi (Certhidea), see Certhidea (Certhidea olivacea), see Certhidea (Fregata minor), see Fregata (Nesotriccus), see Nesotriccus
 rostratus (Camarhynchus), see C. psittacula
 rothschildi (Geospiza), see G. scandens rothschildi (Geospiza scandens), see Geospiza
 ruber (Phoenicopterus), see Phoenicopterus
 rubinus (Muscicapa), see Muscicapa
 salvini (Camarhynchus), see C. parvulus salvini (Camarhynchus parvulus), see Camarhynchus (Certhidea), see Certhidea olivacea (Geospiza), see Camarhynchus parvulus salvini (Geospiza prothemelas), see Camarhynchus parvulus salvini
 scandens (Cactornis), see Geospiza (Geospiza), see Geospiza (Geospiza scandens), see Geospiza semipalmata (Ægialitis), see Charadrius (Hiaticula), see Charadrius (Symphemia), see Catoptrophorus semipalmatus inornatus semipalmatus (Ægialeus), see Charadrius (Charadrius), see Charadrius septentrionalis (Geospiza scandens), see G. septentrionalis septentrionalis (Geospiza septentrionalis), see Geospiza sharpei (Creciscus), see C. spilonotus (Porzana), see Creciscus spilonotus simillima (Geospiza), see Geospiza fortis (Geospiza dubia), see Geospiza fortis (Geospiza fortis), see Geospiza fortis solitaria (Tringa), see Tringa solitarius (Helodromas), see Tringa Spheniscus humboldtii, 33 mendiculus, 33
 spilonota (Ortygometra), see Creciscus spilonotus (Porzana), see Creciscus spilonotus (Zapornia), see Creciscus spilonotus spilonotus (Creciscus), see Creciscus Squatarola helvetica, 58 squatarola, 58
 Steganopus tricolor, 64
 Stercorarius pomarinus, 64 pomatorhinus, 64
 Sterna fuliginosa, 66 fuscata crissalis, 66
 stolidus (Anous), see A. s. galapagensis (Megalopecterus), see Anous stolidus galapagensis
 strenua (Geospiza), see G. magnirostris
 Strepsilas interpres, 59
 Strix punctatissima, 75
 subalaris (Puffinus), see P. obscurus subalaris (Puffinus lherminieri), see P. obscura subalaris (Puffinus obscurus), see Puffinus
 Sula brewsteri, 38
 cyanops, 37
 dactylatra granti, 37
 gossi, 38
 granti, 37
 leucogaster, 38
 nebouxii, 37
 piscator, 37

- piscator websteri*, 37
piscatrix, 37
piscatrix websteri, 37
variegata, 37
websteri, 37
sundevalli (Ardea), see *Butorides*
 (*Butorides*), see *Butorides*
Sylvicola aureola, 132
Symphemia semipalmata, 60
Tachypetes aquilus, 39
Telespiza, 27
tethys (Oceanodroma), see *Procellaria*
 (*Procellaria*), see *Procellaria*
 (*Thalassidroma*), see *Procellaria*
tenebrosus (Puffinus), see *P. obscura*
 subalaris
Thalassidroma tethys, 35
Totanus brevipes, 61
 fuliginosus, 61
townsendi (Camarhynchus), see *Camarhynchus psittacula*
 (*Geospiza psittacula*), see *Camarhynchus psittacula*
tricolor (Steganopus), see *Steganopus*
trifasciatus (Mimus), see *Nesomimus*
 (*Nesomimus*), see *Nesomimus*
 (*Orpheus*), see *Nesomimus*
Tringa bairdii, 59
 minutilla, 59
 solitaria, 60
 solitaria cinnamomea, 60
Tringoides macularius, 61
Tyto punctatissima, 75
variegata (Sula), see *S. dactylatra granti*
variegatus (Camarhynchus), see *Platyspiza crassirostris*
versicolor (Querquedula), see *Querquedula*
violacea (Ardea), see *Nyctanassa violacea*
 pauper
 (*Nyctanassa*), see *N. v. pauper*
violaceus (Nyticorax), see *Nyctanassa*
 violacea pauper
websteri (Sula), see *S. piscator websteri*
 (*Sula piscator*), see *Sula*
 (*Sula piscatrix*), see *S. piscator websteri*
wenmani (*Nesomimus parvulus*), see *Nesomimus*
Xema furcata, 65
 furcatum, 65
Zapornia spilota, 52
Zenaida galapagoensis, 67
 galapagoensis, 67

ERRATUM

Page 21, line 11, for fig. 18, p. 290 read opp. p. 138

PACIFIC OCEAN

Underlined figures in the water in parentheses indicate the height above the plane of high water of the adjacent island or rock.



The Rabbits of California

BY

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JOINT CONTRIBUTION FROM THE
MUSEUM OF VERTEBRATE ZOOLOGY OF THE UNIVERSITY OF CALIFORNIA
AND THE CALIFORNIA ACADEMY OF SCIENCES

SAN FRANCISCO
CALIFORNIA ACADEMY OF SCIENCES

1940

OCCASIONAL PAPERS NO. XIX
OF THE CALIFORNIA ACADEMY OF SCIENCES

Issued May 25, 1940

COMMITTEE ON PUBLICATION

DR. F. M. MACFARLAND, *Chairman and Editor*

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CONTENTS

	PAGE
Introduction	1
Acknowledgments	1
Materials	2
Measurements and Weights	2
Geographic Variation	4
Analysis of Characters	9
Secondary Sexual Variation	20
Pelage	20
Fresh adult pelage	21
Worn pelage	24
Juvenile pelage	24
Postjuvenile pelage	25
Abnormal Coloration	25
Molts	26
Species having one annual molt	27
Species having two annual molts	29
Spring molt	30
Fall molt	32
Life History	33
Diagnostic Key to the Leporidae of California	35
Species Accounts	37
<i>Lepus townsendii</i>	37
<i>Lepus washingtoni</i>	50
<i>Lepus californicus</i>	62
<i>Sylvilagus nuttallii</i>	98
<i>Sylvilagus auduboni</i>	110
<i>Sylvilagus bachmani</i>	140
<i>Sylvilagus idahoensis</i>	162
Literature Cited	202

The Rabbits of California

INTRODUCTION

DURING the past century in North America masses of data have been compiled relative to speciation, subspeciation, and distribution of our native mammals. Few groups now remain which have not been worked over in more or less detail by students of systematics, in an effort to detect and describe such racial variations as exist and to define the ranges of various forms. When comparison is made of the wealth of information now available in this field with what is known concerning the life histories of our smaller mammalian species the former is seen to quite outweigh the latter. With these points in mind at the outset of this work it was planned that both systematic and life history studies should proceed hand in hand.

The family Leporidae was selected for several reasons. Although world wide in distribution, it contains but a relatively small number of genera and species. Probably nowhere, however, are more representatives of this restricted group found over so limited an area as in California, where seven species are known to occur. The topographic, climatic and vegetational differences present throughout various portions of this state open a field rich in possibility for speculation concerning reasons for racial trends or specific constancies. Furthermore, of equally great importance, was the abundance of material in the form of study skins, skulls and skeletons available from California, as well as the accessibility of these various species for natural history observations.

ACKNOWLEDGMENTS

I wish to express sincere thanks to the following institutions or persons for the loan and use of certain material employed in this study: the United States National Museum, the California Academy of Sciences, the San Diego Museum of Natural History, and Mr. Ralph Ellis.

Acknowledgment is made of the many assistances rendered by members of the Museum of Vertebrate Zoölogy, especially by Miss Annie M. Alexander, the late Dr. Joseph Grinnell and Dr. E. Raymond Hall. I wish to extend my thanks for the many courtesies received to the California Academy of Sciences, particularly to Dr.

F. M. MacFarland and to Mr. James Moffitt. To the latter I am in debt for a number of photographs and certain field notes. Many assistances in connection with the typing and handling of manuscript were rendered by Mrs. Dorothy S. Orr.

MATERIALS

In all 1158 specimens, representing the 7 species of rabbits occurring in California, were examined in the course of this study. Needless to say many other specimens of these species and of other members of the Leporidae, taken outside the borders of this state, were used in order better to understand specific relationships and racial trends. All color terms employed, with the exception of those of very general application were taken from Ridgway's *Color Standards and Color Nomenclature* (1912).

Most of the field work was carried on between the years 1930 and 1932, although occasional trips for field study were made up to the close of this work in 1936. Personal examination was made of every faunal area in California which is inhabited by leporid species. Effort was also made to extract all pertinent life history information, both from the literature and from the field notes kindly supplied by my colleagues.

Unless otherwise indicated, all specimens employed in this study are in the collection of the University of California Museum of Vertebrate Zoölogy.

MEASUREMENTS AND WEIGHTS

All measurements used in connection with the systematic accounts are given in millimeters. Unless otherwise indicated external measurements were secured by field collectors from animals in the flesh. In certain instances, where sufficient data were lacking, the length of ear was obtained from dry study skins for comparison. Cranial measurements (fig. 1) were made with the use of a vernier caliper. For the sake of greater accuracy averages were computed with an adding machine and checked for possible mistakes. The following measurements were selected with care out of a considerably greater number for use in this study:

Total length.—Distance between tip of nose and posterior end of last caudal vertebra.

Tail vertebra.—From base of tail to tip of last vertebra. Due to

the small size of this appendage and because of the dense growth of hair covering it in rabbits, the writer when taking this measurement did so after the animal had been skinned. The tail was held at right angles to the body and pressed closely against a ruler.

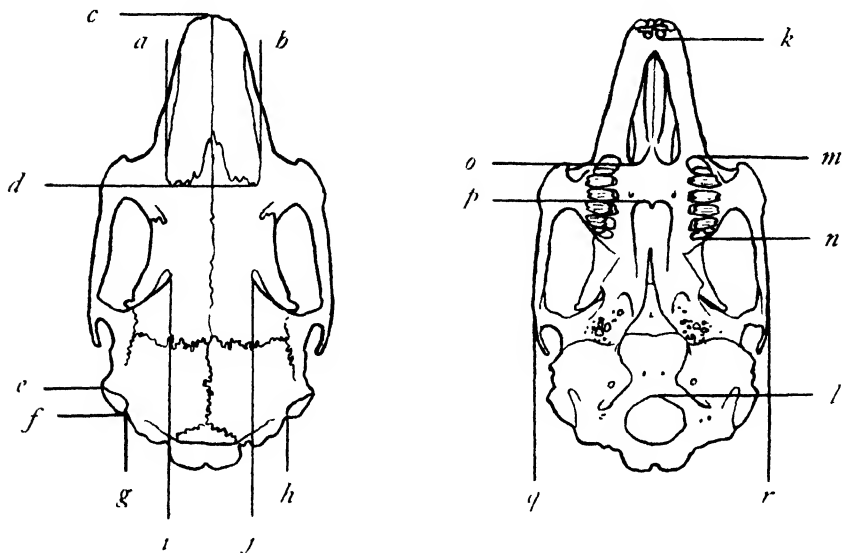


Fig. 1.—Dorsal and ventral views of skull (—) of *Sylvilagus audubonii audubonii* showing measurements employed.

Basilar length, *k-l*

Zygomatic breadth, *q-r*

Postorbital constriction, *i-j*

Length of nasals, *c-d*

Width of nasals, *a-b*

Length of molar series, *m-n*.

Diameter of external auditory meatus, *e-f*

Breadth of brain-case, *g-h*

Length of palatal bridge, *o-p*.

Hind foot.—From the posterior margin of the heel to the tip of the longest claw.

Ear length.—Due to the fact that there are two methods of taking ear length this measurement was discarded in all cases where doubt arose as to which system had been employed by field collectors. Ear from crown, the least accurate of the two methods, is obtained by measuring along the median external surface from the base of the ear where it touches the crown of the head to the tip of the pinna. Ear from notch, a much more exact measurement, is the distance from the base of the notch to the tip of the pinna.

Basilar length.—Distance between posterior border of alveoli of second upper incisor and the most anterior portion of the foramen magnum, measured along median line (fig. 1, *k-l*).

Zygomatic breadth.—The greatest distance between the outermost borders of the zygomata (fig. 1, *q-r*).

Postorbital constriction.—The least lateral diameter of the skull between the postorbital notches (fig. 1, *i-j*).

Length of nasals.—Greatest length of nasals, measured along median line (fig. 1, *c-d*).

Width of nasals.—Greatest combined width of nasals (fig. 1, *a-b*).

Length of molar series.—The combined antero-posterior length of the maxillary tooth row, measured from the anterior alveolar border of the first molariform tooth to the posterior alveolar border of the last molariform tooth (fig. 1, *m-n*).

Diameter of external auditory meatus.—The greatest inner diameter of the external auditory meatus at its orifice (fig. 1, *e-f*).

Breadth of brain-case.—The least lateral diameter of the posterior portion of the brain-case between the innermost sides of the external auditory meatuses (fig. 1, *g-h*).

Length of palatal bridge.—The least length of the bony palate measured midway between the median line and the dental alveoli in an antero-posterior direction from the posterior border of the anterior incisive foramina to the anterior border of the interpterygoid fossa (fig. 1, *o-p*).

Weights.—All weights are recorded in grams or fractions thereof. In instances where collectors have indicated weights of specimens in pounds or ounces the author has, for uniformity of treatment, transposed these figures into the metric system.

GEOGRAPHIC VARIATION

A considerable amount of geographic variation occurs throughout the ranges of certain leporid species within the boundaries of California. This is particularly true of forms inhabiting the portions west of the main Sierra Nevada. The brush rabbit (*Sylvilagus bachmani*) presents a good example of this, breaking up into at least eight well-defined races. Typical Great Basin species, such as the white-tailed jack rabbit (*Lepus townsendi*) and pigmy rabbit (*Sylvilagus idahoensis*), on the other hand show no constant subspecific differences throughout the territory which they occupy within this state.

Two factors appear to be responsible in considerable degree for the specific differences shown in amount of subspeciation. The first of these is the variability versus constancy of the environment over

the area occupied, and the second is inherent within the animals themselves, namely, the ability for dispersal. These two factors tend to counteract each other, one acting to produce, by means of the action of natural selection on heritable variations, a number of distinct populations, and the other to bring about a mixture of these populations, so that they fail to remain as more or less separate entities. Therefore, we may say that over any given area, where environmental conditions vary, those forms which possess the greatest ability for dispersal are less likely to break up into local races than those forms which lack in considerable measure such ability. In other words, among the former the constant movement and blending of populations tends toward constancy of characters, whereas in the latter the sedentary nature of such populations is more apt to foster the development of local variants.

It may be argued on the other hand that the selective effect of environment is always of greater importance than the ability for dispersal. Furthermore, it is quite possible that differences in degree of subspeciation among related species occupying more or less mutual territory may, in part, be the result of differences in the rate at which genetic variations are occurring. At present, unfortunately, we know but little concerning such specific differences in frequency of occurrence of genetic variations among closely related wild species. It holds true, however, among the various leporids studied, that those forms within whose ranges obvious environmental differences occur show a negative correlation to exist between degree of geographic variation and specific ability for individual and mass population movement.

In order to show more clearly what is meant by this let us consider two species of rabbits, *Lepus californicus* and *Sylvilagus audubonii*, whose ranges coincide to a large extent. Both of these species, likewise, exhibit considerable geographic variation. The range of *Sylvilagus audubonii*, however, is more limited than that of *Lepus californicus* (cf. Nelson, 1909). Despite this fact the former species breaks up into a relatively larger number of geographically distinct forms in proportion to the size of the area it occupies (actually there are more races of *Lepus californicus* than of *Sylvilagus audubonii*). Within the range of *Lepus californicus texianus* alone there are four races of *Sylvilagus audubonii*. These are *S. a. warreni*, *cedrophilus*, *baileyi* and *minor*.

Lepus californicus is a wide-ranging animal, each individual being capable of traveling a number of miles daily, if necessary. Furthermore, observations have shown that seasonal changes in availability of food sometimes result, locally, in mass population movements or migrations (cf. Couch, 1927. p. 313; Grinnell, Dixon and Linsdale, 1930. p. 546), such as are undergone occasionally by varying hares (cf. Cox, 1936. p. 216). Individuals of *Sylvilagus audubonii*, on the other hand, seldom travel more than one hundred yards daily from the burrows or forms which they inhabit. Indeed rarely do they wander this far. So far as known large population movements never occur among members of this species. A comparison of the bodily structures of these two species gives adequate reason for these differences in habits. *Lepus californicus* is large in size, possesses relatively long hind legs, rendering it capable of covering large distances with rapidity, and possesses a keen sense of hearing. *Sylvilagus audubonii* is much smaller in size, possesses relatively shorter hind legs, adapted to cover ground rapidly but only for very short distances, and does not seem to have as keenly an exercised sense of hearing as does the larger species. These specific differences in capacity for moving about, in other words, differences in ability for dispersal, would seemingly tend to account for the greater number of geographic races in the smaller, less widely ranging species. Natural selection would function as a more potent factor in the case of *Sylvilagus audubonii* because of the improbability of interference through the mixing of populations.

In southeastern California, on the Mohave and Colorado deserts, where *Lepus californicus* and *Sylvilagus audubonii* are the only two lagomorphs present, a somewhat similar situation occurs, although in a more incipient stage. So far as known there is no significant difference in rate of reproduction between these two species here, and each possesses but one recognized geographic race over the entire area. The smaller, more sedentary form, however, shows several minor geographic variations which, although too slight to be recognized as of racial value, are nevertheless constant and appear to be adaptations to local conditions. Specimens from the Death Valley region, where extremely arid environmental conditions prevail, possess somewhat more ashy tones of coloration, as well as slightly longer ears, than do those from other portions of southeastern California. Skins from near Salton Sea, Imperial County, and in imme-

diately adjoining portions of Lower California tend to be slightly more reddish than is characteristic of the race throughout its general range. This may be correlated with the general reddish hue of the soil over much of this area. The tendency to break up into minor local populations is not manifested in *Lepus californicus*, which exhibits much greater uniformity over the same region.

Three species of rabbits inhabit the major portion of the Great Basin area of California on the east side of the Sierra Nevada. The largest and most widely ranging species is the white-tailed jack rabbit (*Lepus townsendii*). Next in size and ability for dispersal is the black-tailed jack rabbit (*Lepus californicus*). The smallest species, aside from the pigmy rabbit (*Sylvilagus idahoensis*), whose range is so limited in California as to render discussion of this species negligible here, is the Nuttall cottontail (*Sylvilagus nuttallii*). While these three forms by no means occupy the same habitats, their general ranges do for the most part coincide. *Lepus townsendii*, which is most capable of population movement, shows no perceptible geographic variation, in so far as could be determined, throughout this region. *Lepus californicus*, a somewhat smaller species and less subject to seasonal movements, shows some slight variation over the same region. Specimens of *Lepus c. wallawalla* from Modoc County, possess auditory bullae which average smaller than do those of specimens representing the race *deserticola* from the Mono-Inyo faunal area. *Sylvilagus nuttallii*, due to its structural features and habits, is much more sedentary than either of the above species. Two fairly well-defined races, differing from each other in more than one respect, occur in California.

Here again we find a negative correlation existing between degree of geographic variation and ability for dispersal. This does not necessarily imply, however, that other factors may not have been responsible, at least in part, for these differences in degree of subspeciation. It is quite probable that the selection rate is different for each of these species. *Sylvilagus nuttallii* is present in far greater numbers than is *Lepus townsendii* and likely is subject to attack by a relatively larger number of predatory species. Furthermore, certain other environmental factors may affect each of these species differently.

Sylvilagus bachmani represents a species which is limited to a very definite type of surrounding. Generally speaking it is restricted to

the chaparral belt or an equivalent type of cover throughout cismontane California. The perceptible climatic and vegetational changes which take place from the humid northwest coastal belt to the arid southern ranges, combined with the habitat restriction of this species and its limited ability for dispersal would seem to be largely responsible for the great amount of racial differentiation which it exhibits.

Sylvilagus idahoensis, although lacking in subspecific differentiation, is even more limited than *Sylvilagus bachmani* in its ability for dispersal. The habitat occupied by this species, however, is extremely uniform throughout. As a consequence this would lend support to the belief that geographic variations within a species represent adaptations on the part of different populations to the particular environmental conditions under which they live.

Those species, such as *Lepus californicus* and *Sylvilagus auduboni*, whose ranges include the Sacramento and San Joaquin valleys as well as the southeastern deserts, show a gradual change with respect to geographically varying characters from north to south throughout the regions lying north and west of the deserts. This is correlated with a gradually changing environment. None of the subspecific characters ascribed to races in this cismontane region can be said to be uniform over any considerable distance. They change slowly but constantly from one extreme in the north to another in the south. The changes, however, in these variable characters from those of races found in the San Joaquin Valley to those of races found in the desert regions, just a few miles to the south and east, occur within a relatively short distance. Moreover, the subspecific characters possessed by races in the desert show a great degree of constancy over a very large area. This, likewise, is correlated with fairly uniform environmental conditions.

The *Sylvilagus bachmani* group presents an outstanding example of a species which varies in regard to a number of characters, almost continually, from one end of its range to the other. Using a single character such as color we may explain more fully what is meant. The greatest intensity of pigmentation is found at the extreme northern limits of the range of the species in Oregon. From here south, the degree of pigmentation gradually becomes less and less, and as we go from the coast inland, we also find the color becoming noticeably paler. Finally, in California, we observe the most pallid

types of coloration in the upper, arid portions of the Salinas Valley, and in the mountainous parts of eastern San Diego County.

It cannot be said that any one tone of color is maintained uniformly over a great area. Even certain "islands" appear locally and tend to break this uniform north-to-south change. There is, for example, a tendency toward a greater intensity of pigmentation in the Santa Cruz Mountains and a more pallid coloration close along the eastern shores of Monterey Bay than is seen along the coast either to the immediate north or south of these two localities. The latter is probably due to the influence of the Salinas Valley as the color of the species becomes extremely pallid in the upper parts of this valley. The point to be borne in mind, however, is that color is not maintained uniformly, even over the ranges of single subspecies. The same condition holds true for most of the other geographically varying characters of this species.

In general most variable characters attain one extreme in the north or northwest part of the state, and the opposite extreme in the southern or desert portions within the species *Lepus californicus*, *Sylvilagus auduboni* and *S. bachmani*. The greatest total length, the darkest coloration, the smallest ears and the smallest auditory bullae are possessed by races occupying the upper Sacramento Valley or the northwestern coast area. The reverse is true of those races which occur in the southern desert regions. If the change were gradual and uniform in regard to all characters, from the northern to the southern part of the state, there would be little justification for describing races between these extremes, other than that of taxonomic convenience. It so happens that in most species there are certain characters which do not attain their greatest development at the extreme ends of their ranges. To cite one example, within the species *Sylvilagus bachmani* members of the race *tehamae*, occurring in and around the upper part of the Sacramento Valley, are characterized by the possession of a rostrum which is relatively shorter and broader at the base than is possessed by other subspecies either to the north or south. Similar examples are afforded by other races.

ANALYSIS OF CHARACTERS

A general consideration follows for each of the characters used in this study. As will be seen there is much parallel variation exhibited among the different species, especially where their ranges are more

or less coincident. An attempt has been made to interpret certain of these geographic variations as adaptations to local environmental conditions.

Color.—As is true of most species of mammals occurring throughout California, the darkest coloration is possessed by those races of rabbits inhabiting the northwest coastal region and the upper Sacramento Valley. This dark coloration is exhibited, but in lesser intensity, along the immediate vicinity of the coast south to San Diego County, although races in the latter area are seldom as dark as those of the more northern coastal regions. The color of specimens from farther inland and farther south, irrespective of species, becomes noticeably paler, until in the southeastern deserts the most pallid types of coloration are found. The same tendency toward extremely pale tones of color is manifested in the dry interior valleys such as the Salinas Valley and Cuyama Valley. It is of interest to note that a dark type of pelage on the dorsal surface of the body appears to be correlated with a tendency toward a buffy rather than a white terminal band on the hairs of the ventral parts. Benson (1933, p. 46) mentions this correlation in regard to color of dorsal and ventral pelages among a number of different groups of mammals. This is true of the darkest race of brush rabbit (*Sylvilagus bachmani uericolor*) and the darkest race of black-tailed jack rabbit (*Lepus californicus californicus*) occurring in California. Other races of black-tailed jack rabbits show a tendency toward buffy color beneath but this never attains the intensity seen in *L. c. californicus*.

Much has been written concerning the dark color of birds and mammals occurring in more northern and more humid regions, as contrasted with the pallid tones possessed in general by most desert-inhabiting forms (cf. Sumner, 1925; Buxton, 1928; Rensch, 1929; etc.). While many authors concur on the theory that such trends in variation may be protective in nature and, consequently, represent adaptations on the part of different populations to those environmental conditions under which they exist, certain objections have been raised. Sumner (1925, p. 365) mentions a few of these. McAttee (1932), after a study of the stomach contents of a large number of Nearctic birds, denies the protective value of color in those forms of animals which are preyed upon by avian species. Experiments on mosquito-fishes (*Gambusia patruelis*) made by Sumner (1934, 1935), on the other hand, have definitely showed that those individuals

which blend in color with their background are much less subject to attack by certain predators than those which stand out in contrast with their environment. Since, in most instances, dark color among the higher vertebrates is correlated with humidity and pallid color with aridity, the possibility of a direct effect of such atmospheric conditions on pigmentation has often been questioned. Recent studies made by Dice (1930) and Benson (1933) on certain mammals in New Mexico, which vary extremely in color over relatively short distances in direct correlation with the color of their environment, have failed to produce any evidence in support of the theory that relative humidity or temperature are directly responsible for such trends in variation.

Among those species of rabbits which vary to any extent, geographically, in California there appears to be a very definite correlation between the color of pelage possessed by the various races and the color of the respective environments which they occupy. Relatively dark forms, such as *Lepus californicus californicus*, *Sylvilagus auduboni auduboni*, *Sylvilagus bachmani ubericolor* and *S. b. tephamae*, occur in the upper Sacramento Valley and the northwestern coastal belt where the humidity is relatively high as also is the annual precipitation. The abundance of moisture here tends to create a dark background by encouraging the growth of a luxuriant, shade-producing vegetation. Furthermore, habitats occupied by species which rely upon brush for cover, are darker where there is a greater amount of vegetation due to the formation of humus on the surface of the soil. The pallid colors of desert races correspondingly blend to a remarkable degree with a desert environment. Low relative humidity and slight annual rainfall in such areas have resulted in a reduction in quantity of vegetation. Such herbs and shrubs as are present possess, in general, a very glaucous appearance. Even in upland deserts such as the Great Basin plateau of northeastern California it cannot be denied that the grayish tones of pelage possessed by *Lepus townsendi townsendi*, *Lepus californicus wallawalla*, *Sylvilagus nuttalli nuttalli* and *Sylvilagus idahoensis* occurring there blend almost perfectly with the color of the sagebrush which is outstandingly dominant in the flora of that region.

Lepus washingtonii and *Sylvilagus bachmani* as species, irrespective of various racial differences which appear throughout their ranges, are darker on the average than any other leporids occurring

in California. Needless to say this refers to the first mentioned species only during the late spring, summer and early autumn months. This appears significant when we consider that the habitats of *Lepus washingtonii*, during the summer period, and of *Sylvilagus bachmani*, the year around, are darker than those of any other species of rabbits in this state. Both forms inhabit dense undercover where the surface of the ground is strewn with dark leaf litter and the overhanging vegetation excludes a great deal of light. In winter throughout most of the range of *Lepus washingtonii* where snow is normally present, members of this species correspondingly assume a white pelage, while in those areas where snow is of irregular occurrence individuals of this same species frequently are brown at this season. Indeed it is not difficult to uphold the protective value of white winter pelage in variable animals such as *Lepus washingtonii* and *Lepus townsendii*.

Body measurements.—An attempt was made throughout to employ the four standard body measurements in studying geographic variation. It may be said at the outset that little information was derived from the measurement "length of tail vertebrae." This is due to the extreme shortness of this member in the group and the great differences which may arise through methods employed by individual field collectors in taking this measurement. Each of the other three measurements proved to be of value in indicating geographic variation.

In most instances the greatest body length is exhibited by those races inhabiting the northern and western parts of the state, and, in all instances, the smallest races are those living on the southeastern deserts. Tail length appears, roughly, to be correlated directly with total length, although, as stated above, this could not be accurately determined. Length of hind foot definitely is correlated directly with body size as indicated by total length.

Ear length, in all of the species studied which show marked geographic variation, is seen to vary in an inverse ratio to body length. In other words, within individual species, it may be stated generally that those races which possess the greatest body length have the smallest ears, both relatively and actually, and those races which measure smallest in regard to body length possess the largest ears.

Basilar length.—This measurement, as might be expected, is directly correlated with body size. Within particular species those

forms which possess the greatest total length also measure largest in basilar length.

Zygomatic breadth.—While, in general, zygomatic breadth appears to vary in direct proportion to basilar length there is also seen in those races which occupy the upper Sacramento Valley region a tendency toward relatively greater zygomatic breadth, in relation to basilar length, than elsewhere. This is true of *Lepus californicus californicus*, *Sylvilagus auduboni auduboni* and *Sylvilagus bachmani tehamae*. It is difficult to supply any adequate reason for this structural peculiarity possessed in common by races of three distinct species occupying this geographic region.

Shape of rostrum.—This is governed to a large extent by the length, breadth and contour of the nasals. Those forms which possess long, narrow nasals usually have a rostrum which is likewise long and narrow. In general, it may be said that those races which occur in, or bordering, the upper Sacramento Valley possess rostra which are proportionately large and very broad at the base. This appears to be correlated with the relatively great zygomatic breadth possessed by these races, both characters contributing toward a broad type of head.

Anterior palatine foramina.—The shape of these foramina, whether broad or narrow, depends largely upon the shape of the rostrum. Within the *Sylvilagus bachmani* group decided geographic variation is exhibited in respect to the presence, absence or degree of constriction along the latero-posterior borders of these foramina. None of the other species studied show this type of variation to be other than individual, or, at most, specific in character. In *Sylvilagus bachmani* a very marked posterior constriction is seen in specimens from the northern part of the range of the species, becoming less noticeable in those from central California and practically missing in individuals from the southern part of the state.

Supraorbital processes.—In the *Lepus californicus* group the heaviest processes with the broadest postorbital attachments are possessed by the race *californicus* of northern California. The more southern races show a lesser development of these processes. The only other species showing marked geographic variations in regard to the shape of these structures is *Sylvilagus bachmani*. Here we witness a reversal of the condition seen in *Lepus californicus*, namely, the smallest supraorbital processes are possessed by those races inhabiting northern

California, whereas the broadest type, with wing-like postorbital attachments touching the skull posteriorly, are characteristic of the more southern races. The greatest development of the postorbital portion of the process, within this species in California, is seen in the race *cinerascens*, although the character becomes even more pronounced in forms inhabiting the peninsula of Lower California. Another striking feature, dependent largely upon the shape of the postorbital attachment, is the form of the postorbital notch in the *bachmani* group. North of San Francisco Bay this notch is oval in shape (see fig. 2), whereas, south of the bay it abruptly becomes slit-

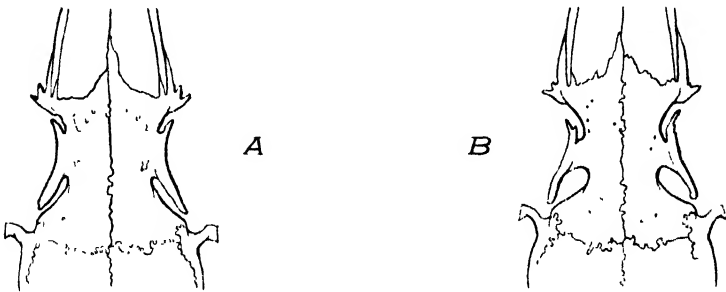


Fig. 2-4 Frontal region of skull of *Sylvilagus b. macrotimnus*, no. 53383, Mus. Vert. Zool., from San Mateo County, California. B, Frontal region of skull of *Sylvilagus b. tuberculor*, no. 20575, Mus. Vert. Zool., from Marin County, California (both $\times 1$). Note the difference in shape of postorbital notch in these two specimens representing races from either side of San Francisco Bay.

like. There is no intergradation or even overlapping, with regard to the change in the shape of this structure, either north or south of the bay along the immediate coast, although this change does occur gradually along the western flanks of the Sierra Nevada within the ranges of the races *lehmani* and *mariposa*. The measurement "postorbital constriction," indicating the least lateral diameter of the skull between the postorbital notches, was found to vary geographically in proportion to size of skull.

Teeth.—Both incisiform and molariform teeth vary geographically, with regard to size, in those species which show marked racial variation in general body size. The races which are largest and possess, relatively, the heaviest skulls likewise have the broadest incisors and longest molariform tooth rows.

Length of palatal bridge.—The manner in which this character varies geographically differs distinctly among various species. Unlike most of the other characters studied, there is no indication here

of any parallel development throughout the different groups. In California, *Lepus washingtonii* possesses the longest type of palatal bridge at the extreme southern end of its range in the central Sierra Nevada. Within the *Lepus californicus* group, the races *deserticola* and *wallawalla*, occupying the southeastern deserts of California and the Lassen-Modoc Great Basin area, respectively, possess the longest type of palate exhibited by any of the races of this species in California. The most elongate type of palatal shelf found throughout the range of *Sylvilagus audubonii* in California is seen in specimens from the extreme southwestern part of the state within the limits of the subspecies *sanctidiegi*. The other three races of this species occurring here show a great deal of uniformity, relative to size, regarding the length of this structure. In *Sylvilagus bachmani* a gradual change is seen from north to south, throughout its range, from a relatively long type of palate to one which is relatively short.

Breadth of brain-case.—This character varies in direct proportion to basilar length in those species showing racial differences in size of skull.

Diameter of external auditory meatus.—The diameter of the external auditory meatus varies directly according to the size of the auditory bulla. Due to the impossibility of satisfactorily measuring the diameter of the latter this measurement was used merely as an indicator of the variation which occurs in many species with regard to this structure.

Auditory bullæ.—In general, within those species studied, size of auditory bulla is found to be correlated directly with size of external ear. *Lepus californicus*, *Sylvilagus audubonii* and *S. bachmani*, the three most widely distributed species in California, show a marked parallel development in regard to the manner in which this structure varies geographically. In each instance the largest races possess the smallest bullæ and *vice versa*. *Lepus townsendi*, *L. washingtonii*, *Sylvilagus nuttallii* and *S. idahoensis* fail to show any very appreciable geographic differences in size of bullæ in this state. Within the *Lepus californicus* group the smallest auditory bullæ are possessed by the race *californicus*, which occurs throughout the Sacramento Valley, the northern and the central coastal regions. The change is gradual from this small type of bulla at the northern and western range of the species to one that is large and inflated in the southern desert areas. In the race *wallawalla* of the northeastern Great Basin

section the bullæ average slightly smaller than those seen in *deserti-cola* of farther south, although much larger than found in *californicus* proper. *Sylvilagus audubonii* exhibits a similar type of variation in that the race *audubonii*, of the Sacramento Valley, possesses the smallest auditory bullæ, and the race *arizonæ*, of the southeastern deserts, the largest. There is a gradual but constant increase in size of auditory bullæ in *Sylvilagus bachmani* from north to south throughout the range of the species. Likewise, more inland races appear to possess larger bullæ than those which are of the same latitude but situated nearer the coast.

Field observations have repeatedly shown that hearing is relied upon by rabbits to a greater extent than any of the other senses in detecting the presence of enemies. Individuals, when feeding in the open, where they are constantly in danger of attack by birds of prey and carnivorous mammals, continually shift their ears about in an effort to detect any unusual sounds. The senses of sight and of smell apparently are of relatively little importance in this regard when compared with hearing. If one moves noiselessly he may approach very close to a rabbit, even in the open, without the latter showing awareness of the observer's presence. As a consequence such marked geographic variation in regard to the size of a structure so intrinsically important for survival as is the auditory apparatus in this group appears significant.

While by no means definitely established as a fact, it is nevertheless highly probable that increased development of the sound reception apparatus in more southern races is correlated with greater ability to hear. It is difficult to see how a large external pinna in forms which hold their ears erect could fail to be of greater assistance in the detection of sound than a smaller pinna. Furthermore, it is likely also that increase in size of tympanic membrane and bulla is an aid to sound reception. If this be true it follows that races occurring in more southern and more interior regions are possessed of a greater ability to hear than those inhabiting more northern and more coastal areas. If such subspecific differences in sensory ability do exist, how then may we account for them?

Two possible explanations present themselves. First, either the natural enemies of these species are more numerous in these southern and interior regions, thus necessitating greater ability to hear on the part of those species relying upon this sense to detect danger

or, secondly, sound reception itself is more difficult here. There appears to be no substantial evidence in support of the first suggestion. It is true that in general the number of species of carnivores increases from north to south, but this is hardly perceptible over such a limited distance as the length of California. The only additional mammal enemy to which certain species of rabbits in the southern part of the state are subject is the kit fox (*Ulpes macrotis*). The brush rabbit (*Sylvilagus bachmani*) is probably never preyed upon by the kit fox as the two species do not inhabit common territory. The brush rabbit, however, shows the same geographic trend, in regard to ear structure, as either the black-tailed jack rabbit or the Audubon cottontail. Also, within the range of this carnivore, races of both the black-tailed jack rabbit and the Audubon cottontail, inhabiting the southern San Joaquin Valley and the San Diego faunal district, possess smaller ears and bullæ than do races of either species occurring on the Mohave and Colorado deserts. The factor of natural enemies therefore seems negligible.

We come then to the second alternative, namely, that sound reception is more difficult in regions which either have a low relative humidity or a high mean annual temperature or both than is true of areas which are climatically the reverse. Recent experiments by Knudsen (1931, 1935, 1936) on the absorption of sound in gases have definitely shown this to be true. Gray (1936, p. 129) gives a summary of Knudsen's findings as follows: "... cold sub-zero air is partially transparent to sound, but with heat the air becomes increasingly absorptive until at high temperatures it is so opaque to high-pitched sounds as to make the latter inaudible at a distance of a few feet. In the case of humidity this progressive relationship does not hold. Perfectly dry air is the most transparent acoustically, air containing a pinch of moisture (about 10 to 20 per cent relative humidity) is the most opaque, and thereafter with added moisture the ratio of absorption decreases until at 92 per cent relative humidity the transparency to sound is almost back to maximum. This latter condition corresponds to the moist fog-laden air of the ocean, while air which is only 20 per cent humid approximates that of the desert."

Within the range of those races of *Sylvilagus bachmani* occurring along the coast of California from Del Norte to San Diego counties a gradual increase is seen in size of auditory bullæ and external ears from north to south. Reference to the map shown by Grinnell (1922,

p. 15) giving the "relative humidity of the air, for the month of April, as related to area in California" indicates very little difference in relative humidity over this entire area. Consequently, so far as moisture in the atmosphere is concerned, no acoustical differences would be apparent. However, according to the maps occasionally published by the Weather Bureau of the United States Department of Agriculture showing mean annual isotherms for California, a gradual increase in mean annual temperature takes place along the coast from north to south. Maps issued for the years 1914 to 1917, inclusive, and 1919 show the mean annual temperature over these years to range from 52° to 56° F. along the northwestern coast south to Marin County, from 54° to 60° F. between San Francisco and Pt. Conception and from 58° to 62° F. between Pt. Conception and San Diego County. Therefore, in view of Knudsen's findings it may be presumed that sound transmission is more difficult in coastal southern California than in coastal northern California, due to increasingly higher annual temperatures farther south.

There is practically no difference in mean annual temperature between the Sacramento and San Joaquin valleys and the southern coastal area. The relative humidity in the latter region, however, is somewhat higher than in the former. If we are to believe that natural selection has in any way influenced the development of a better type of auditory apparatus in races inhabiting regions where sound transmission is less perfect, we should therefore expect southern coastal subspecies of *Lepus californicus* and *Sylvilagus audubonii* to possess slightly smaller auditory bullæ and external ears than the inland valley forms of these same species. Such is not the case. The auditory bullæ and external ears of *Lepus c. bennettii* and *Sylvilagus a. sancti-diegi* average somewhat larger, respectively, than do those of the Sacramento Valley forms *Lepus c. californicus* and *Sylvilagus a. audubonii*. It must be remembered that the southern coastal area is relatively narrow, and is immediately adjacent to that portion of the state which possesses the lowest relative humidity and the highest mean temperature. Quite possibly the influence of nearby populations of these rabbits, possessing as they do extremely large ears and bullæ, is accountable for these discrepancies. Grinnell and Swarth (1913, p. 367), referring to *Lepus c. deserticola*, which in their opinion is the race of black-tailed jack rabbit occurring in the western portion of the San Jacinto Mountain region, say: "The relatively

well developed powers of locomotion of this rodent, even though a species primarily of the lowest zone at the arid base, might be held to account for its invasion Pacificwards with its pallid coloration scarcely altered at the farthest station on the more humid side of the mountains. It would appear that the index of dispersal of the desert race *deserticola* is in this region greater than that of the Pacific coast race *bennettii*. As a result characters of desert origin are carried well over upon faunal ground more properly belonging to the darker coast race." In other words, to use the term applied by these authors (*loc. cit.*, p. 393) differences in "intraspecific vigor" may account for one race occurring where another might be expected. It would seem possible, therefore, that certain well-developed characters of one wide-ranging, vigorous race might become superimposed, at least in part, upon a more limited and less vigorous race of the same species immediately adjacent.

Lepus californicus is the only species of rabbit whose range not only includes cismontane California and the southeastern deserts but the Modoc Great Basin area as well. On the basis of the mean annual temperature of this latter region, which ranges from 42° to 52° F., we should expect the race *Lepus c. wallawalla* that occurs there to possess the smallest bullæ and ears of any form of this species in the state. On the other hand, based upon relative humidity, we should expect the ears and bullæ of members of the race *wallawalla* to be as large as those of individuals representing *deserticola* of the western Mohave and Colorado deserts, since the relative humidity is approximately the same in both regions. Actually, the race *wallawalla* is characterized, in part, by the possession of auditory bullæ and external ears which are slightly smaller than those of the form *deserticola*.

In general it can best be said that the auditory apparatus, in those species of rabbits which exhibit geographic variation with respect to this character in California, is developed to a considerably greater degree in areas where sound transmission, due to unfavorable atmospheric conditions, is more difficult than it is in regions where atmospheric conditions are more favorable for the transmission of sound. If increased development of auditory structure means increase in ability to hear, as appears likely, such a trend in variation represents an adaptation to local environmental conditions.

SECONDARY SEXUAL VARIATION

A constant average size difference was found to exist between the sexes in each of the species studied, the females being slightly larger than the males. This, of course, is only apparent when a sufficient number of specimens are averaged. The following table indicates the sexual size difference in regard to total length for each of the species studied in California.

TABLE 1
AVERAGE SEXUAL DIFFERENCES IN TOTAL LENGTH IN THE
LEPORIDÆ IN CALIFORNIA

<i>Lepus townsendii</i>	♀ ♀ 3.2% larger than ♂ ♂
<i>Lepus washingtoni</i>	♀ ♀ 12.0% larger than ♂ ♂
<i>Lepus californicus</i>	♀ ♀ 1.4% larger than ♂ ♂
<i>Sylvilagus nuttallii</i>	♀ ♀ 3.7% larger than ♂ ♂
<i>Sylvilagus auduboni</i>	♀ ♀ 1.9% larger than ♂ ♂
<i>Sylvilagus bachmani</i>	♀ ♀ 2.1% larger than ♂ ♂
<i>Sylvilagus idahoensis</i>	♀ ♀ 1.1% larger than ♂ ♂

In general this difference is not very large. The seemingly large sexual difference in *Lepus washingtoni* is undoubtedly due to an insufficient number of specimens being averaged. In those forms which possess more than one subspecies in California the percentage of difference between the sexes was determined separately for each race, and these resulting figures were averaged together to determine the sexual difference in total length for the species.

No color differences are present and, except during the breeding season when the testes of the males are enlarged, it is difficult to find any external differences between the sexes.

PELAGE

A detailed study of hair and pelage, while highly desirable, has not been considered as within the scope of this work. An attempt has been made, however, to standardize the methods used in describing the various forms. A description is given below of the normal color pattern seen in the seven species of rabbits included in this study. While many specific differences are to be noted, there is, nevertheless, a general similarity in respect to color pattern. In the color descriptions of species and subspecies not all zones of color or bands on the hairs of the various parts of the body are mentioned; con-

sideration is given only to those that govern external bodily appearance and, consequently, are of most importance to the systematist. Only the terminal and subterminal bands of the guard hairs are seen in unworn pelage on the dorsal parts of the body, hence a description of the color bands below these is usually omitted. Likewise, for the sake of convenience, only two types of hair, namely, guard hairs and under-fur are considered. The guard hairs, which are the more important of the two in determining the general body color, are attenuated basally and coarse distally. The under-fur is relatively much finer in texture, somewhat resembling the basal part of the guard hairs.

Fresh adult pelage.—The general body color is produced almost entirely by the overhairs or guard hairs which are much longer and coarser than the under-fur. These hairs on the dorsal part of the head and back possess five main bands of color which may be seen readily on parting the pelage. The basal portion of each hair is some shade of gray, and extends for half the length or more of the hair. Above the basal zone is a light band which in a few forms may be rather indefinite, but in most species is well defined. This is usually some shade of brown or yellowish-tan. Above this a third band is seen which is very dark brown, becoming almost black in some of the darker forms. This represents the terminal band of the under-fur, whereas the former constitutes the subterminal band. The guard hairs which extend distally beyond the under fur, possess, in addition to these three bands, a subterminal band of a yellowish or reddish color, which continues into a black terminal or apical zone of color. These last two mentioned bands are the only two visible on the dorsal parts of the body, without parting the hair. As noted by Castle and Sawin (1932, p. 45), it is the difference in the relative size and extent of the terminal and subterminal bands of the guard hairs together with the color of the latter that produces the general external coloration and color differences as seen among various species and subspecies.

The color and color pattern of the anterior parts of the flanks and the shoulders are similar to that of the dorsum. The areas from the sides of the nose to the anterior parts of the orbits, from the posterior parts of the orbits to the bases of the ears and along the lower parts of the cheeks are paler than the top of the head. This is due sometimes to a definitely paler, subterminal band combined with a re-

duced apical zone of black, or may result largely from a reduction of the apical band of black, as is true in the *Lepus washingtonii* group. An orbital ring surrounding the eye is generally noticeable, consisting of hairs of a light color lacking the terminal black zone. Similarly, a pale area is seen on each side of the nostrils.

The pelage on the outer anterior parts of the ears is finely grizzled, with the subterminal bands of these hairs either of the same color as those on the top of the head, or, as is more often the case, slightly paler. The hairs on the lower anterior margins of the ears are always long in comparison with those of the other parts of the ears, and are white or somewhat buffy with a very small amount of terminal black sometimes present. In all of the species studied the hairs at the margins of the tips of the ears tend to be black. The posterior convex portions of the ears are sparsely covered with dull gray or whitish hairs. The inner parts possess hair to a varying degree, mostly noticeable near the outer edges. The hair present varies from a very small amount, as seen in *Sylvilagus bachmani* and *S. audubonii*, to a relatively heavy growth, as is possessed by *Sylvilagus nuttalli* and *S. idahoensis*. Although usually whitish, in some species, as for example *Lepus townsendii*, these parts are rather richly colored. The nape is scantily haired with under-fur and a finer type of guard hair than is seen on the back. In most instances these hairs are grayish, basally, the distal portions being brighter in color.

On the sides of the body, exclusive of the lateral parts of the shoulders and flanks, the guard hairs are relatively fewer, especially along the lower margins. The subterminal band on these hairs is generally of greater extent and paler in color than is seen on those of the back. The terminal band of black is almost always shorter than on the dorsal guard hairs, and is absent more and more toward the lower margins of the sides. The intermediate zone of color, below the subterminal band, becomes less distinguishable from the lighter band beneath on the more ventrally situated hairs. Finally, on the hairs of the most ventral parts of the sides, these two bands of color attain approximately the same shade as the subterminal band, the three then being indistinguishable from one another, except for the fact that the areas representing the two lower bands are on the narrower part of the guard hairs and on the terminal half of the under-fur.

The color of the rump, while often similar to the rest of the back, is sometimes definitely marked off from the remainder of the upper

parts by a blackish or grayish color. The former is due to a greater extension of the terminal black band on these hairs, whereas the latter is the result of a more pallid, subterminal band which may sometimes be almost white as seen in *Sylvilagus nuttallii*.

The pelage on the tops of the fore legs and on the lateral and posterior parts of the hind legs above the heels differs markedly, in the four species of the genus *Sylvilagus* studied, from either that of the sides or back by its more brilliant color. This is slightly less noticeable in *Lepus washingtonii* and not as well marked in *Lepus californicus* and *L. townsendii*. The most brilliant coloration of these parts, as seen in *Sylvilagus nuttallii*, is the result of a long terminal band of rufous and only a short basal gray area on both overhairs and under-fur, the intermediate zones and the apical black band being absent entirely. In the three other members of the genus *Sylvilagus* the two intermediate zones of color are present on these hairs, but are of a brighter tone, not differing greatly from the subterminal band above. A very small apical band of black is usually present. This is approximately the condition seen in the three members of the genus *Lepus* studied, with the degree of intensity of pigmentation and the varying extent of the bands producing the differences seen. The color of the lateral and posterior parts of the hind legs in these species differs but little from the color of the flanks except for the reduced apical band of black on the hairs.

The tops of the fore feet are generally paler than the upper parts of the fore legs. The upper parts of the hind feet are covered with short fur which is mostly white. When the hairs are pigmented distally, this color is first seen on the hairs covering the outer sides of the feet and in darker forms gradually encroaches on the tops of the feet progressively from the centers of these areas. The hairs between the bases of the toes are generally brighter than those on the other parts of the feet except in *Lepus washingtonii*, in which the feet are usually entirely white. The soles of the feet are heavily covered with a bristle-like type of hair which forms a dense mat. These hairs are whitish or dusky in color.

The hairs on the ventral parts of the body, exclusive of the chest, are usually gray basally and white distally. In the darker forms this terminal band is relatively shorter, in proportion to the basal gray band, than in the lighter forms and may even be buffy. In *Lepus californicus* the terminal parts of these hairs are generally of a buffy

or reddish color, varying to a considerable extent subspecifically. A similar condition is found to occur among certain members of the *Sylvilagus bachmani* group. In *Sylvilagus audubonni*, *Lepus townsendii* and *L. washingtonii* the median ventral pelage is white from tip to base. The chest differs from the chin and belly in that the pelage is of similar appearance to that of the back except for the apical band of black which is either extremely reduced or absent altogether. In all of the species studied the vibrissæ are either all black, or those most ventrally situated are white throughout or on the distal half.

Worn pelage.—A description of worn pelage for each species has been purposely omitted due to the impracticability of adequately describing such. The amount of wear on the hair varies greatly, both with the individual and with the locality. Two specimens of approximately the same age and taken at the same time from the same locality may differ to a marked degree in amount of wear. Likewise, it has been noted, especially within the species *Sylvilagus bachmani*, that fading takes place to a greater extent and more rapidly in those areas within the range of the species where it is hottest and most arid.

The first stage observed in the process of the wearing of the pelage on the upper parts is a fading of the black tips of the guard hairs to a very dark shade of brown and a fading of the subterminal bands of these hairs to a lighter shade than they formerly possessed. This is followed by a gradual wearing and even ultimate breaking off of the tips of the guard hairs until the under-fur is seen in spots. The result of this is a more brownish appearance in general. Wearing may even continue, before new pelage is assumed, until the under-fur is in evidence almost uniformly over the upper parts, sometimes with the basal gray color showing through in places. The pelage on the ventral parts of the body and the legs seldom shows the amount of wear seen on that of the dorsal surface, although the bright color on the legs of certain forms fades very appreciably.

Juvenile pelage.—This pelage differs noticeably from the normal adult pelage in appearance. The guard hairs are proportionately fewer in number with the pigmentation of the terminal band usually dark brown in color, instead of black as seen in the adults. The actual diameter of these individual hairs is considerably less in the juveniles. Due to the scarcity and lesser diameter of guard hairs, in contrast to the adult condition, a considerable amount of the under-fur

is in evidence resulting in a woolly appearance. The general color relationships of the various parts of the body are maintained as in the adults, although the same degree of contrast is not seen, since the pelage is of a duller hue.

There is but little difference, geographically, in the color of the juvenile pelages of most species in comparison with the striking amount of geographic variation seen in the color of the adults of the same species. For this reason a complete color description has not in most cases been given for each race, but is dealt with in general for the species.

Postjuvenile pelage.—This normally succeeds the juvenile pelage and is a transition between the latter and the adult pelage. In most respects this pelage more nearly resembles the adult rather than the juvenile, differing most noticeably from the former in that it appears paler. This washed out effect seems to be the result of a shorter, terminal band of black on the guard hairs. The length of this band is largely responsible for the richly contrasting color of the adults as noted by Nelson (1909, p. 28). The individual hairs of this pelage appear to be less coarse than those of the adult pelage. As regards the colors of the pigment bands of the hair little difference was noted between the postjuvenile and the adult pelage. The former pelage, assumed when the young are about three-fourths grown so far as total length is concerned, although only about half grown as regards weight, is retained almost until maturity is reached.

ABNORMAL COLORATION

No example of albinism was noted in any one of the seven species studied by the writer. A single melanistic individual of *Sylvilagus auduboni*, from Otay Valley, San Diego County, California, is in the collection of the Museum of Vertebrate Zoölogy. The terminal half of the guard hairs, with the exception of those present on the undersides of the feet and a few scattered white hairs on the ventral parts of the body, are black. The under-fur and the basal portion of the guard hairs are of the same plumbeous color possessed by normal individuals of this species from the same general region. The hairs on the undersides of the fore and hind feet are normal in color.

The skins of two brush rabbits (*Sylvilagus bachmani*) in the collection of the Museum of Vertebrate Zoölogy, while neither melanistic nor albinistic, are so abnormal in appearance that it seems worth

while to give a description of each. One of the specimens is a sub-adult female (No. 32811) from near Pacheco, Contra Costa County, California. The terminal half of the guard hairs on the back, the sides of the body, the shoulders and the flanks are pale smoke gray. The under-fur and the basal half of the guard hairs on these parts are deep gull gray, becoming dark plumbeous on the sides and ventral parts of the body. There is, however, an area on the anterior part of the back where the under-fur and basal half of the guard hairs are pure white. This strip begins just behind the nape and extends posteriorly, as a band about 20 mm. in width, for a distance of approximately 100 mm. While the hairs, in general, on the head are similar in color to those of the back there is a faint indication of an ochraceous, subterminal band on the guard hairs of the top of the nose, sides of the head, just anterior and posterior to the eyes, and on the top of the head. The interorbital regions and the cheeks are similar in color to the back. The coloration of the hairs on the ears, nape, tail, fore legs, fore feet, the lower portions of the hind legs and the hind feet is perfectly normal. The guard hairs of the chest, although much like those of the back in color, have a weakly indicated subterminal band of yellow. This specimen was in fresh winter pelage, being taken on December 21.

The other individual (No. 33481) is an adult, sex unknown, captured at San Jose, California, on July 4. The terminal half of the guard hairs on the head, sides of body, shoulders and outer parts of the hind legs varies in color from mouse gray to hair brown. The under-fur and basal portions of the guard hairs on these parts are dark gull gray. A subterminal band with a small amount of yellow pigment is indicated on some of the guard hairs on the lower margins of the sides of the body. The hairs on the top of the tail are similar to those of the back in color, whereas the hairs on the ventral side of the tail are white, as seen in normal specimens. The pelage on the ventral parts is normal in color.

MOLTS

Rabbits may, in general, be classed under two categories on the basis of the number of pelages assumed annually during the adult period of life. In California all members of the genus *Sylvilagus* and the species *californicus* of the genus *Lepus* (subgenus *Macrotolagus*) undergo but one molt annually after attaining maturity. *Lepus*

townsendii and *Lepus washingtonii* (both of the subgenus *Lepus*) are variable, undergoing two molts yearly, one in the spring and the other in the fall.

The following accounts of the changes in pelage are based largely upon examination of study skins taken at critical times during this process. Captive individuals of certain species were observed, but proved valuable in the study of pelage changes only when taken after the molt had begun. Individuals kept in captivity any length of time prior to molting showed both a delayed molt and an irregularity in the manner of its progress.

Species having one annual molt.—Those species which are included under this heading undergo an annual molt in the fall of the year. Practically no specific or geographic differences were noted with respect to the time at which this takes place. It was found to occur usually between the latter part of August and the early part of October. In all of these species, namely, *Lepus californicus*, *Sylvilagus nuttalli*, *S. auduboni*, *S. bachmani* and *S. idahoensis*, the manner in which the change from the old to the new pelage takes place was found to be essentially the same. When the new pelage first makes its appearance, in the process of changes from the juvenile to postjuvenile, from the postjuvenile to the adult, or from the worn adult to the fresh adult coat, it is still covered by a considerable amount of the old worn fur. The latter is gradually lost as the former becomes longer.

Evidence of new fall pelage is most often seen first on the top and sides of the head, appearing as a strip extending from the tip of the nose backward, between the eyes, to the bases of the ears, and as lateral strips extending from the sides of the nose posteriorly along the cheeks to the neck. This new pelage is later seen to extend from the cheeks, ventrally, to the chin where the advancing lines of new pelage approach from each side until they meet along the median-ventral line. Almost simultaneous with, and occasionally previous to, the appearance of new hair on the top of the head and the cheeks, is the appearance of new pelage on the middle of the back. This soon advances anteriorly toward the nape and posteriorly in the direction of the rump.

When this state has been reached, new pelage appears on the fore parts of the shoulders, soon extending down onto the tops of the fore legs. Likewise, at this same time, new pelage appears on the anterior

parts of the flanks. The posterior borders of these patches of new hair rapidly progress back across the dorsal parts of the flanks to the posterior margins, thence down to the heels.

In most instances the new pelage appears to develop more rapidly on the shoulders and top of the head than elsewhere, although it is not unusual to find specimens at this stage which have undergone a more rapid increase in length of hair and extension of the area occupied by it on the back.

The strips of new hair, progressing backward along the sides of the neck from the cheeks, continue posteriorly to the shoulders where they meet the advancing lines of new pelage from these areas. In *Lepus californicus* new pelage is seen to appear on the sides of the neck at a somewhat later stage than noted in the other species of this molt group. In *Sylvilagus bachmani* the lines of new pelage on the neck and shoulders advance dorsally from either side to meet in the center of the nape, thence progress forward to the inter-ear region and backward to meet the line of new hair advancing from the back. When new pelage in this species has come in almost completely from the top of the head to the rump, exclusive of the latter area and the ears, the molt begins to extend ventrally on the shoulders and sides of the body. In all of the other members of the genus *Sylvilagus* studied and in *Lepus californicus*, however, this latter step takes place before the advancing lines of new pelage have reached the nape region. New hair appears more or less simultaneously over the central and posterior parts of the shoulders, the sides of the body and the anterior parts of the hind legs. The molt lines progress down the anterior and outer parts of the fore legs and hind legs to the feet. Replacement of hair takes place on the tail at approximately the same time as on the sides. After new pelage has been completely assumed on the back, the posterior molt line proceeds backward on the rump in the form of a V with the apex situated anteriorly. This V-shaped molt line progresses posteriorly on the rump, diminishing continually in size until it finally reaches the tail. New pelage usually appears on the ears, advancing distally in an irregular manner from their bases, before the molt is completed on the rump. The anterior outer surfaces of the ears attain new pelage before the inner posterior surfaces. The amount of hair present on the other portions of the ears is so small that it was not found possible to determine when replacement takes place. In all species of this group, with the ex-

ception of *Sylvilagus bachmani*, new pelage appears on the nape, encroaching on this region from the sides of the neck and the back at approximately the same time as on the rump.

The ventral parts of the body are last to attain new pelage. The molt lines from each side advance irregularly until they meet along the median-ventral line.

The change from juvenile to postjuvenile pelage and from postjuvenile to adult pelage was found to take place in essentially the same manner as the adult change of pelage in the fall. However, a great deal more individual variation appears to occur in these sub-adult molts. For example, it is not unusual for the new pelage to first appear in scattered patches on the sides of the body instead of on the top of the head and the back.

Species having two annual molts.—To this group belong *Lepus townsendii* and *Lepus washingtonii*. Both of these species undergo a complete change of pelage in the spring and again in the fall of the year. Owing to an insufficient number of skins representing *Lepus townsendii* at all of the critical stages during the two molt periods, it was impossible to determine the exact manner in which these two pelage changes take place in this species. For this reason the detailed description which follows is based upon specimens of the species *Lepus washingtonii* alone. Nevertheless, a number of skins of *Lepus townsendii* showing certain stages of the molts in progress were examined by the writer, and this examination clearly showed that the manner in which the two molts take place is similar in the two species.

In California the winter coat possessed by *Lepus townsendii* is almost completely white, as opposed to the grayish-brown pelage possessed by members of this species in summer. In some other regions throughout the range of *townsendii* the winter pelage is only partially white (cf. Nelson, 1909, p. 73). *Lepus washingtonii* turns completely white in winter throughout its range in the Sierra Nevada of California. Farther north, both in this state and in southern Oregon, many winter-taken specimens exhibit a brown coat not unlike the summer pelage. According to Nelson (*loc. cit.*, p. 105) throughout the northern portion of the range of this species in Washington and British Columbia the winter pelage is always brown like the summer pelage.

Considerable attention was given by the present writer to the

much mooted question as to whether the white winter coat of variable animals, such as the snowshoe rabbit and the white-tailed jack rabbit, is the result of a complete growth of new pelage and molt of the brown summer pelage or is due to blanching of the summer coat. It may here be stated briefly that all evidence derived from a study of the pelage changes in *Lepus townsendii* and *Lepus washingtonii* seems to confirm the opinions of Allen (1894), Grange (1932*b*) and others, who contend that there is a complete or, at least, nearly complete new pelage assumed in winter in the case of the varying hare, as opposed to the ideas held by Merriam (1884), Hadwen (1929, 1931), Gunn (1932), *et al.*, who claim that this apparent change is not due to new hair but is a result of a blanching and growth of the old hair.

Specimens of both *Lepus townsendii* and *Lepus washingtonii* examined during the early part of the autumnal color change showed new white pelage coming in below the surface of the brown hairs. These white hairs were seen to be somewhat scattered and slightly irregular in location, due probably to the greater irregularity of the fall molt as compared with the vernal molt. In no instance was any intermediate condition observed where the individual brown hairs were seen changing to a white color, as stated by Merriam (*loc. cit.*) and implied by Gunn (*loc. cit.*). The hairs at this critical period were either entirely white, whether short or long, or else they possessed the normal pigmented bands seen in summer pelage.

In California summer pelage is assumed both by *Lepus townsendii* and *Lepus washingtonii* during April and May, the time varying individually and, doubtfully, with the year and locality. One specimen of *Lepus w. tahoensis* taken on May 9, 1927, at Lake Tahoe, Placer County, is in nearly complete summer pelage, whereas another taken on May 14, of the same year, has summer pelage just beginning to appear on the back. Winter pelage usually is assumed in October by members of both species.

It is of interest to note the similarity in progress of molt and attainment of new pelage between *Lepus americanus phaeonotus*, which was carefully studied by Grange (1932*b*), and *Lepus washingtonii tahoensis*, herein described. The differences to be noted for the most part are slight.

Spring molt.—Just prior to the first appearance of summer pelage a scarcity of long white guard hairs is evident over the body. This is

apparent only upon close examination since the general surface color is still white. Summer pelage is first seen on the orbital rings, being most pronounced immediately dorsal and anterior to the eyes. Almost simultaneous with this is the appearance of new dark fur on the back, particularly on the posterior third of this dorsal surface, exclusive of the rump. Summer pelage becomes noticeable at this time on the top of the head and along the cheeks. When new pelage has almost completely replaced the old on the back and top of the head it appears on the rump and along the sides of the body, with the exception of narrow strips extending from the undersides of the front legs along the lower parts of the sides of the body to the anterior portions of the hind legs and down the anterior margins of the hind legs to the tops of the hind feet. The head at this time is in summer pelage, with the exception of the top and sides of the nose, a strip extending from the top of the nose to the crown, a strip extending on each side from back of the orbital regions to the bases of the ears and a line running from the inner base of one ear to the inner base of the other across the crown. The ears are still white at this stage, being almost the last portion of the body to complete the spring molt and in this respect differing markedly from *Lepus a. phænotus* (see Grange, 1932*b*). One specimen examined at this particular period has its new pelage nearly complete on the ventral parts, including the chest, whereas in another it is only partially complete. The tail and rump attain new pelage at approximately the same time. The last regions to complete the molt are the areas extending from behind the eyes to the bases of the ears, the ears, both internally and externally, strips extending from the undersides of the fore legs to the tops of the hind feet along the sides of the body, and the outer portions of the hind legs.

As may readily be seen on comparison the spring molt in this variable species shows a marked similarity in the manner of its progress to the fall molt of those species which undergo, as adults, but one complete pelage change annually. Lack of adequate material showing the change from juvenile to postjuvenile pelage and from postjuvenile to adult pelage made it impossible to determine accurately the manner in which these changes take place. It appears probable, however, that the subadult molts progress in much the same manner as the adult spring molt. Specimens representing

Lepus townsendii in process of change from postjuvenile to adult pelage indicated this to be true in the case of that molt for this species.

Fall molt.—In *Lepus washingtonii* the process of molting in fall, with the consequent appearance of the white pelage, is nearly the reverse in manner of progress to that of the spring molt. The first portions to show complete new pelage are the bases and the margins of the ears. When these areas are nearly white new pelage next becomes noticeable on the anterior parts of the ears. Specimens examined at this stage appear to have new winter pelage on the ventral parts of the body, while the undersides of the neck and the chin are still in process of molt, with new white hairs to be seen below the general surface of the old pelage that still remains. Likewise, the sides of the nose are also partially white. Next to attain the white pelage are the areas extending from the postero-orbital regions to the bases of the ears, and from the ventral surfaces of the fore legs along the sides of the body to the anterior margins of the hind legs and the outer parts of the flanks. No specimens were examined representing the stages occurring between this condition and the complete winter coat. However, judging from the number and length of the new white hairs seen coming in on the rump and tail as compared with those seen on the back and top of the head it would seem as though new pelage was assumed last of all on the back and top of the head. The fact that the feet are white at all seasons of the year rendered it impossible with the material at hand to determine when molting takes place on these parts.

Two skins of *Lepus townsendii*, in the collection of Ralph Ellis, taken on October 16, 1929, at the eastern base of the Ruby Mountains, Elko County, Nevada, at first presented somewhat of a problem as regards pelage phases. In both instances the pelage on the back appears new and of the normal banded summer type, although the ears and feet possess normal winter pelage. On one specimen new white pelage is evident below the surface of the relatively fresh summer coat on the rump, ventral parts and lower margins of sides. The other individual, additionally, possesses some new, short, white hairs on parts of the back and on the head between the nose and the eyes.

As both of these individuals are small in size it became apparent

that they were young of the year which had attained their adult summer pelage relatively late, and had then proceeded almost immediately to change to the white winter coat.

LIFE HISTORY

A detailed knowledge of life history is essential where any attempt is being made to correlate structural modifications of races of geographically varying species with the environment which they inhabit. Even in the case of those forms which fail to show subspecific differentiation, habitat studies made throughout their ranges frequently offer adequate explanation for the absence of such variation. Consequently, in the course of this work, effort was made to gather all available information relative to the natural history of the species treated herein. Instead of separating data under subspecific headings, for those forms which vary geographically, each species has been dealt with as a unit. In this way much unnecessary repetition has been avoided. Locality data, however, have been included wherever it seemed advisable so that facts of racial significance may be more readily discerned. Effort has, likewise, been made to give somewhat detailed descriptions of the various habitats occupied by rabbit populations in different faunal areas within the range of each species.

Owing to the relative scarcity in California of certain species, such as the white-tailed jack rabbit, snowshoe rabbit and pigmy rabbit, the life history accounts of these forms are very meager. On the other hand species such as the black-tailed jack rabbit, Audubon cottontail and brush rabbit are dealt with in much greater detail. More information was obtained concerning these latter forms, due partly to their greater abundance in this state, and partly to the fact that territory which they inhabit was much more accessible to the writer. Information pertaining to rabbits outside of California has been used in many instances, either to render accounts more complete or for the sake of comparison.

In view of the fact that a complete life history account of the black-tailed jack rabbit in southern Arizona has but recently been published by Vorhies and Taylor (1933), it was considered advisable to eliminate certain material in this paper which would merely constitute a repetition of their findings. Many phases of the life history

of this species were found to be identical in both areas. Differences, however, in certain features were noted on close comparison.

While no attempt was made during the course of this study to obtain information relative to the species dealt with from a purely economic point of view, all available data have been included that in any way bear upon the destruction of agricultural crops in California by rabbits within recent years. Much has been written concerning the economic importance of these animals, especially the black-tailed jack rabbit, which in years past was a serious menace, locally, to agricultural activities. We find accounts of instances (*cf.* Palmer, 1896) where from ten to twenty thousand hares were killed in a single day during a rabbit drive in the San Joaquin Valley. Today black-tailed jack rabbits are rarely found in numbers sufficient to endanger agricultural interests in this state. This change in economic status, quite unlike that of certain other mammalian species, such as the California ground squirrel (*Citellus beecheyi*), is apparently the result of intensified farming which has brought about the subdivision of large tracts of land, an increase in the density of human population, a removal of native food plants and, of greatest importance, a destruction of the type of cover upon which these rabbits are dependent.

White-tailed jack rabbits, snowshoe rabbits and pigmy rabbits are either so scarce or so limited in their distribution within this state as to be of practically no economic importance whatsoever. Cottontails and brush rabbits on the other hand may, on occasion, prove detrimental to farm crops in certain localities. It is only natural that grain fields and truck gardens occurring immediately adjacent to brushland inhabited by either of these forms will prove to be attractive feeding grounds and, as a consequence, suffer from marginal feeding on the part of these animals. Certain precautions, however, based on a knowledge of the habits of these species, may be taken which often assist in reducing or eliminating these losses. Knowing, for example, that brush rabbits rarely venture more than a few yards from dense cover it is easily seen that the removal of a strip of brush, not more than ten to fifteen yards in width, adjacent to a planted field will adequately protect it from invasion by these animals. Where such losses are due entirely or in part to cottontails, a protective strip of greater width is, of course, necessary. These sug-

gestions are offered merely to show some of the many possible practical applications that may be derived from life history studies.

DIAGNOSTIC KEY TO THE LEPORIDÆ OF CALIFORNIA

The following key consists merely of a brief summary of certain of the more important specific characters of the seven species of leporids found in California.

Size, large; hind foot 110 mm. or longer; interparietal never distinguishable in skulls of adults; one or two annual molts.genus *Lepus*.

Size, very large; hind foot averaging 148 mm.; two annual molts; tail conspicuously large and white, both above and below; ears large; supraorbital processes very broad and considerably elevated above the frontal plane; basilar length over 65 mm.

Lepus townsendi.

Size, medium, hind foot averaging less than 135 mm.; one annual molt, tail large with prominent, black median band above, never white below; ears large; supraorbital processes narrower and only slightly elevated above frontal plane; basilar length over 65 mm.

Lepus californicus.

Size, small; hind foot averaging less than 125 mm.; two annual molts; tail small, lacking conspicuous coloration; ears small; supraorbital processes small and only slightly elevated above frontal plane, basilar length less than 60 mm.*Lepus washingtoni*.

Size, small; hind foot 110 mm. or less, interparietal always distinguishable in skulls of adults; one annual moltgenus *Sylvilagus*.

Size, large, ears relatively short, rounded and heavily haired on inner surface; tail proportionately large and noticeably white beneath; hairs on mid-ventral parts of body seldom gray at base; feet heavily haired; antorbital projections of supraorbital processes short and pointed; posterior margin of palatal shelf usually lacking a median spine; anterior surface of first upper molariform tooth possessing three re-entrant angles; posterior halves of second to fourth lower molariform teeth possessing lateral diameters which are rarely equal to more than one-half lateral diameters of anterior halves, ridge of enamel separating individual molariform teeth into anterior and posterior sections strongly crenulated along median two-thirds.*Sylvilagus nuttalli*.

Size, large; ears relatively long, pointed and sparsely haired on inner surface; tail proportionately large and noticeably white beneath; hairs on mid-ventral parts of body usually white at base; feet not heavily haired; antorbital projections of supraorbital processes of medium length and seldom pointed; posterior margin of palatal

shelf usually possessing a median spine; molariform teeth essentially the same as described for *Sylvilagus nuttallii* except that posterior halves of second to fourth lower molariform teeth possess lateral diameters which are approximately equal to four-fifths lateral diameters of anterior halves. *Sylvilagus audubonii*.

Size, small; ears relatively short, pointed and sparsely haired on inner surface; tail relatively small and whitish beneath; hairs on mid-ventral parts of body gray at base; feet not heavily haired; ant-orbital projections of supraorbital processes of medium length and not noticeably pointed; posterior margin of palatal shelf with or without a median spine; molariform teeth essentially as given for *Sylvilagus auduboni* except that the ridge of enamel separating individual molariform teeth into anterior and posterior sections shows but slight indication of crenulation. *Sylvilagus bachmani*.

Size, very small, ears short, rounded and heavily haired on inner surface; tail very small and not conspicuously colored beneath; hairs on mid-ventral parts of body gray at base; feet heavily haired; ant-orbital projections of supraorbital processes very long and slender; posterior margin of palatal shelf possessing a median spine; anterior surface of first upper molariform tooth possessing but a single re-entrant angle; posterior halves of second to fourth lower molariform teeth possessing lateral diameters equal to about one-half lateral diameters of anterior halves; ridge of enamel separating individual molariform teeth into anterior and posterior sections lacking any crenulation *Sylvilagus idahoensis*.

SPECIES ACCOUNTS

Lepus townsendii Bachman

WHITE-TAILED JACK RABBIT

Plate 1

Specific diagnosis.—Size, very large, with total length of adults varying from 565 to 655 mm.; hind legs and ears relatively long; adults undergoing two annual molts; color in summer pelage, grayish brown; color in winter pelage, white, throughout most of the range of the species; tail proportionately large and entirely white except for a slender, dusky, median-dorsal strip which may or may not be present; skull, relatively short and arched; rostrum broad at base and tapering but little; supra-orbital processes broad and noticeably elevated above the frontal plane; postorbital projections of supraorbitals tapering abruptly from a broad base and sometimes coming into contact with the squamosals, distally; jugals broad with a prominent flange projecting outward, laterally, from their dorsal margins; brain-case broad; anterior palatine foramina slightly constricted posteriorly; palatal bridge short, both relatively and actually, in comparison with other members of the genus; palatal bridge lacking a conspicuous postero-median spine; auditory bullæ relatively small; molariform teeth large.

Lepus townsendii townsendii Bachman

Plate 1

Lepus townsendii BACHMAN (1839, p. 90), original description; AUDUBON and BACHMAN (1849, p. 25).

Lepus campestris, WATERHOUSE (1848, p. 127), part; ALLEN (1875, p. 433), part.

Lepus campestris sierræ MIRRIAM (1904 a, p. 132), part; ELLIOT (1907, p. 385).

Lepus campestris townsendi, MIRRIAM (1904 a, p. 132); part; NELSON (1909, p. 78).

Lepus campestris townsendii, MILLER (1912, p. 347), part.

Lepus townsendii townsendii, HOLLISTER (1915, p. 70), part; GRINNELL (1933, p. 198), part.

Lepus townsendii sierræ, HOLLISTER (1915, p. 70), part; GRINNELL (1933, p. 199), part.

Type.—Immature female (present location unknown; probably no longer extant according to Nelson, 1909, p. 78); from Old Fort Walla Walla, near present town of Wallula, Walla Walla County, Washington; collected by J. K. Townsend.

Geographic distribution.—In summer, the higher parts of the northeastern Great Basin area of California, south along the crests and eastern slopes of the Sierra Nevada to the Mt. Whitney region in Tulare and Inyo counties; in winter, descending to a lower level



Fig. 3.—Range of the white tailed jack rabbit (*Lepus townsendi*) in California

on the eastern side of the Sierra Nevada. Zonal range, Upper Sonoran to Hudsonian, inhabiting the higher zones mostly in summer and descending to the lower in winter. Altitudinal range, from 4700 to over 12,000 feet, depending upon the season (fig. 3).

Diagnosis.—Closely resembling *Lepus townsendi campanius*, from which *townsendi* may be distinguished principally by its more

grayish tone of coloration (less buffy) and longer ears (*cf.* Nelson, 1909, p. 78).

Adult pelage.—*Summer:* The following description is based upon an average specimen in unworn pelage from Modoc County, California. Subterminal band of guard hairs on back and top of head pale ochraceous-buff; terminal band of black relatively short in comparison with darker races of *Leporidae* in California (no skins of *L. t. campanus* were available for subspecific comparison); basal zone of these hairs varying from dirty white to cinereous; guard hairs on rump fewer than on back, some being black from tip to base; under-fur at base of tail nearly white; tail almost entirely white except for presence of some banded guard hairs at dorsal base and a few along median-dorsal part; anterior, outer parts of ears similar to top of head in color and finely grizzled, becoming distinctly more pinkish-cinnamon toward tips; near outer margins of ears the terminal zone of black on hairs disappears and along the margins themselves, from notch to approximately three-fourths of the distance to tip, the hairs become long and white, except at tips where hairs are black; inner posterior parts of ears sparsely covered with whitish hairs except in central portions, within one-half inch of margins, where hairs are grizzled not unlike those on anterior, outer surfaces; hairs along inner posterior margin of ears pinkish-cinnamon, this color becoming more extensive near tips of ears; nape dusky; sides of nose and areas from back of eyes to bases of ears paler than top of head, due largely to absence or reduction of terminal band of black on hairs, circumorbital rings whitish; vibrissae both black, white, and combinations thereof; sides of body paler than back, not becoming noticeably brighter on extreme ventral margins, guard hairs on tops of fore feet between light pinkish-cinnamon and pinkish-cinnamon, with some hairs possessing a small terminal band of black; tops of fore legs similar to tops of fore feet; tops of hind feet sometimes almost pure white, or guard hairs may be equally white and light pinkish-cinnamon; ventral pelage white from tip to base; chest similar to sides.

Winter: Based upon specimens taken in December in the Ruby Mountains region, Elko County, Nevada. Guard hairs on back and sides white from base to tip; under-fur of back silky white at base with terminal portion varying from cinnamon, as seen in mid-dorsal region, to pinkish-cinnamon on rump and white throughout lower

margins of sides; top of head slightly dusky in appearance with guard hairs all white at tips, although many are not white to base; under-fur on top of head plumbeous at base with intermediate zone of Sayal brown and terminal band of bone brown, the latter partly showing through the guard hairs; white circumorbital rings present; eyelids black; cheeks similar to sides; top of nose buffy; vibrissæ as in summer; ears more heavily haired than in summer pelage; anterior, outer parts of ears finely grizzled with most of the hairs possessing a terminal band of black and a subterminal band of either white or pinkish-buff; toward outer anterior margins of ears terminal band of black disappears, and at very margins of ears the pinkish-buff fades to white, and hairs are noticeably longer; posterior tips of ears black; posterior parts of ears, other than tips, covered with white hairs; inner posterior parts of ears sparsely covered with whitish hairs, except in central portion within one-half inch of margin, where hairs are grizzled not unlike those on anterior, outer surfaces and near tips of ears where terminal black band is lacking and hairs are between light pinkish-cinnamon and pinkish-cinnamon; tops of fore feet light pinkish-cinnamon; lower parts of fore legs light pinkish-cinnamon mottled with white; upper parts of fore legs entirely white; tops of hind feet varying from white to white mottled with light pinkish-cinnamon; hairs of ventral parts pure white throughout except in chest region where under-fur is cinereous basally, and between light pinkish-cinnamon and pinkish-buff distally.

Juvenile pelage.—Similar to adult summer pelage, except for the relatively fewer and finer guard hairs which permit a considerable amount of under-fur to show through; ears lacking much of the brilliant coloration seen on those of adults although pattern is similar; top of tail possessing a proportionately greater number of guard hairs than are present in adult pelage.

Postjuvenile pelage.—Intermediate in appearance between juvenile and adult summer pelages, with ears less brilliant in tones of coloration than seen in the latter; top of tail more nearly resembling in appearance that of juvenile pelage in regard to proportion of dark hairs present.

Skull (pl. 1).—No skulls representing the race *campanius* were available for comparison with *townsendii*, but according to Nelson (1909, p. 80) *townsendii* averages smaller in most respects.

Remarks.—A careful study was made of specimens of *Lepus town-*

endii from California and from the northern Great Basin area to determine the worth of the characters heretofore ascribed to the race *sierra* of the southern Sierra Nevada. No specimens from the type locality of *townsendii* were examined, but a comparison of 27 individuals (20 of them adults) from northeastern Nevada and southeastern Idaho with 11 representatives, supposedly of the race *sierra*, from the eastern slopes of the central and southern Sierra Nevada and adjacent portions of western Nevada has failed to show the presence of a race in the latter areas sufficiently different from *townsendii* to warrant a separate name.

From the account given by Nelson (1909, pp. 78-82) there is no reason to believe that specimens of *townsendii* from southern Idaho and northeastern Nevada differ from typical members of this race from southeastern Washington. The males of the series examined from Idaho and Nevada average slightly smaller in total length than the males from the Sierra Nevada region. This size difference, however, is not borne out by the cranial measurements of the two series. For this reason it may be suggested that the apparent external differences are merely the result of different methods of taking measurements employed by field collectors. According to Nelson (1909, p. 82) the larger ears and hind feet distinguish the Sierra Nevada form. These geographic differences were not found by the present writer. When taken in relation to total length, the length of the hind feet of the Nevada-Idaho specimens averaged 26.0 per cent and those from the Sierra Nevada 26.4 per cent. The measurement of ear from notch in the dried skins averaged 17.9 per cent of the total length for the northern series and 17.8 per cent for the Sierra Nevada series.

Borell and Ellis (1934, p. 40), on the basis of measurements given by Nelson (*loc. cit.*, p. 74), considered members of this species from the Ruby Mountains region of Nevada as intermediate between *townsendii* and *sierra*. Nelson, however, gives external measurements of only the type of *sierra* which is an extremely large adult female, hence misleading if taken as typical of the Sierra Nevada representatives. The cranial measurements given by Nelson for *sierra* are based upon only two specimens, and the averages are so close to those given for *townsendii* that the differences appear negligible in view of the limited number of specimens.

Actually no significant differences were discovered by this writer between skulls of *Lepus townsendii* from the northern Great Basin

area and those from the Sierra Nevada region. Skins of white-tailed jack rabbits from both regions, adequately representing both the summer and winter phases of pelage, have failed to show any constant geographic differences in color at either season. For these reasons it is here proposed that *Lepus townsendi sierræ* Merriam be considered as synonymous with *Lepus townsendi townsendi* Bachman.

Measurements.—The average and extreme measurements of 8 adult males from southeastern Idaho and northeastern Nevada are as follows: Total length, 589.4 (565–618); tail vertebrae, 85.3 (72–102); hind foot, 153.1 (146–165); ear from notch in dried skin (6 averaged), 104.3 (100–106); basilar length, 70.8 (67.6–74.0); zygomatic breadth, 43.5 (42.1–44.9); postorbital constriction, 14.1 (13.0–15.8); length of nasals, 38.6 (36.0–40.8); width of nasals, 20.0 (19.0–21.6); length of molar series, 16.5 (15.8–17.6); diameter of external auditory meatus, 5.4 (4.9–6.1); breadth of brain-case, 28.8 (26.6–30.6); length of palatal bridge, 5.6 (5.2–6.3). The average and extreme measurements of 8 adult females from southeastern Idaho and northeastern Nevada are as follows: Total length, 612.4 (575–655); tail vertebrae, 85.0 (66–100); hind foot, 154.9 (145–159); ear from notch in dried skin (7 averaged), 105.7 (100–113); basilar length, 72.0 (68.1–74.4); zygomatic breadth, 45.2 (44.3–46.7); postorbital constriction, 14.0 (12.3–16.0); length of nasals, 39.4 (37.9–40.3); width of nasals, 21.1 (19.1–21.8); length of molar series, 17.1 (16.4–17.8); diameter of external auditory meatus, 5.5 (5.0–6.3); breadth of brain-case, 29.1 (27.5–30.2); length of palatal bridge, 5.9 (4.9–7.2).

The average and extreme measurements of 5 adult males from Alpine and Modoc counties, California, and Washoe County, Nevada, are as follows: Total length, 601.4 (583–612); tail vertebrae, 83.2 (75–92); hind foot, 158.6 (152–164); ear from notch (3 averaged), 115.3 (111–120); ear from crown (4 averaged), 148.5 (135–154); ear from notch in dried skin, 106.8 (103–109); basilar length (4 averaged), 70.4 (69.4–71.1); zygomatic breadth, 43.9 (43.1–44.4); postorbital constriction, 14.2 (12.9–15.3); length of nasals (3 averaged), 38.0 (36.2–40.3); width of nasals, 20.4 (19.3–22.0); length of molar series, 16.0 (15.1–17.3); diameter of external auditory meatus (4 averaged), 5.1 (4.9–5.8); breadth of brain-case (4 averaged), 28.2 (27.6–29.0); length of palatal bridge, 5.7 (5.1–6.1). The measurements of two adult females from Douglas County, Nevada, and Mono County,

California, are, respectively, as follows: Total length, 621–621; tail vertebrae, 97–109; hind foot, 157–172; ear from crown, 142–161; ear from notch in dried skin, 109–111; basilar length, 69.1–74.7; zygomatic breadth, 44.6–45.4; postorbital constriction, 12.5–15.8; length of nasals, 38.1–39.5; width of nasals, 20.6–22.8; length of molar series, 16.2–17.9; diameter of external auditory meatus, 5.5–5.1; breadth of brain-case, 27.8–29.3; length of palatal bridge, 5.0–6.2.

Weights.—The weights of two adult males, one from near Pocatello, Bannock County, Idaho, and the other from the Ruby Mountains region of Nevada are 2945 and 2491 grams, respectively. The average and extreme weights of 5 adult females from southeastern Idaho and northeastern Nevada are 3070.0 (2635–3440) grams.

Specimens examined.—A total of 16 from the following localities: Modoc County: Steele Meadows, 4700 feet altitude, 1; Parker Creek, Warner Mountains, 6300 feet altitude, 1; Warner Mountains (coll. Calif. Acad. Sci.), 1; Eagleville (coll. Calif. Acad. Sci.), 1; 2 miles east of Pitt River Ranger Station (coll. Calif. Acad. Sci.), 1. Lassen County: Red Rock, 3. Placer County: Tahoe City, Lake Tahoe, 1. Alpine County: Carson Valley, 5270 feet altitude, 1; Woodfords, 1. Mono County: near Summers Meadows, 4 miles southeast of Lower Twin Lake, 8000 feet altitude, 2; Mono Lake, 1; Farringtons, 1. Tuolumne County: Tuolumne Meadows, Yosemite National Park, 1.

LIFE HISTORY

HABITAT

The white-tailed jack rabbit, one of the rarer members of the genus *Lepus* in California, is limited to the crest and east side of the Sierra Nevada and to the higher parts of the northeastern plateau section of the state. While perhaps common in certain restricted localities, its members are by no means abundant anywhere.

The author has had very little opportunity to study this species in the field, but observations of those who have may give some clues as to its habitat predilections. Howell (1924, p. 35), in speaking of this species near Mammoth, Mono County, California, makes the following statement: "White-tailed jack rabbits occur from the sage of Long Valley to above timber line, to which abundant feces and the reports of local residents bear witness." Grinnell and Storer (1924, p. 226), referring to white-tailed jack rabbits around Tuolumne

Meadows, say that "flat-topped hills bearing moderately open stands of trees together with brush were often occupied." Fry (1924, p. 172) makes the general statement concerning this hare in Sequoia National Park: "They inhabit the more open plains and meadow lands on upper timber line."

Merriam (1904a, p. 133) gives the following accounts: "The latter part of September, 1900, John Muir and I, after ascending Bloody Canyon to Mono Pass, came upon one of these large hares among the Murray and white bark pines on the west side about two miles below the Pass and near Dana Creek, which is one of the heads of Tuolumne River. The Paiute Indians at Mono Lake showed me a number of snow-white winter skins of the rabbits, and told me that in winter it comes out of the mountains and inhabits the higher sagebrush slopes on upper Rush Creek. . . ." The tendency of this species to migrate to lower altitudes in winter is likewise indicated by Grinnell, Dixon and Linsdale (1930, p. 544).

During the early part of September, 1935, many signs of this species were noted in the high country back of Emerald Bay in the Lake Tahoe region, Eldorado County, California. Droppings were found in greatest numbers on exposed, flat-topped ridges above the 8500 foot level. The vegetation on these ridges consisted mainly of a few stunted western junipers (*Juniperus occidentalis*) and lodgepole pines (*Pinus contorta*), also clumps of dwarf juniper (*Juniperus communis* var. *montana*), cream bush (*Holodiscus discolor*) and granite gilia (*Leptodactylon pungens*) (figs. 4 and 5).

Rarely are white-tailed jack rabbits found to occupy the same territory with black-tailed jack rabbits. Regarding the habitat difference between these two species in Malheur County, Oregon, Anthony (1913, p. 18) says: "During the summer months, these rabbits [*Lepus townsendii*] stay along the higher foothills and thus are seldom seen. The few that remain in the lower country where the black-tailed, *L. californicus wallawalla*, range, generally choose a different character of feeding ground. The white-tails prefer the open flats and the rye-grass fields or stubble, after haying, and lie very close when one approaches. The black-tail prefers sage-brush and seldom allows a close approach." This same difference in habitat between these two species exists in the eastern part of the state of Washington according to Couch (1927, p. 313) who makes the following statement: "The ranging habits of the two species are slightly different,



Fig. 4—Prostrate conifers which provide shelter for white-tailed jack rabbits at timber-line, on a ridge one mile northwest of Dick's Peak, 9000 feet altitude, Eldorado County, California. Photograph taken by Mr. James Moffitt, July 5, 1924.



Fig. 5—Stunted lodgepole pines, shown in the foreground, frequently serve as cover for white-tailed jack rabbits during the daytime in the Velma Lakes region, Eldorado County, California. Photograph taken by Mr. James Moffitt, July 5, 1924.

the black-tails sticking to the sage brush, while the white-tails find the bunch-grass and rabbit-brush cover more to their liking."

GENERAL HABITS AND BEHAVIOR

According to Howell (1924, p. 35) white-tailed jack rabbits were usually found to spend the day under stunted hemlocks or other low growths high in Mono County, California. Observations made by Mr. James Moffitt (MS) and by the present writer in the high central Sierra Nevada region, immediately west of Lake Tahoe, have shown that stunted western junipers and lodgepole pines are frequently resorted to for cover during resting periods by these rabbits (fig. 7).

In Modoc County, on September 28, 1922, at sundown, a rabbit of this species was aroused from a form when the observer approached within 20 feet of it. The large, white tail, white buttocks and white backs of its ears stood out strikingly. The form from which the animal had been disturbed was situated next to a slab of lava and was partly covered by a clump of sagebrush. The back end of the form, adjacent to the lava, had been excavated to a depth of four inches. The dirt which had been dug out was piled into a mound at the front end of this structure. The width of the form was six inches, its length eighteen and one-half inches (Grinnell, MS).

When running, white-tailed jack rabbits, although relatively heavy bodied, are reputed to cover distances rapidly. Grinnell and Storer (1924, p. 226) cite an observation wherein one of these animals was frightened in a field, stating that "it did not appear to hurry, but its easy run carried it out of sight in an incredibly short time."

C. E. Johnson (1925, p. 247) records an instance where a jack rabbit of this species, when pursued by a dog, was seen to swim boldly across a coulee.

FOOD HABITS

Little is known relative to the food habits of this species in California. Observations made in September, 1935, in territory inhabited by these rabbits near Lake Tahoe, Eldorado County, showed that cream bush (*Holodiscus discolor*) was an important food plant. The abundance of droppings around these bushes and the numerous cut twigs within reaching distance of white-tailed jack rabbits provided ample evidence of this. Sagebrush when available is probably a major item of food, especially in winter.

Regarding the food habits of this species in the state of Washing-



Fig. 6.—Habitat of the white-tailed jack rabbit in winter, one mile southwest of Eagle Lake, 8300 feet altitude, Eldorado County, California. The wind-swept ridges in the distance are preferred by members of this species. Photograph taken by Mr. James Moffitt, December 1, 1931.



Fig. 7.—Hollows beneath stunted western junipers often serve as resting places for white-tailed jack rabbits. Photograph taken by Mr. James Moffitt, December 1, 1931.

ton, Palmer (1896, p. 16) indicates that sagebrush is taken. Furthermore, this same author makes the following statement which is of some economic importance: "Complaints have recently been received from Washington that crops and young orchards near Sunnyside, in the Yakima Valley, have been seriously injured, while near Prescott, Walla Walla County, timber claims planted with black locust trees have been ruined by the white-tailed jack rabbit."

Skinner (1927, p. 249) makes note of a white-tailed jack rabbit that was observed to eat dandelion stems in Yellowstone National Park. Regarding the food habits of members of this species in New Mexico, Bailey (1931, p. 48) says as follows: "During the summer the food of these jack rabbits consists of grass and a great variety of herbaceous plants and also such cultivated crops as they encounter. In winter it is largely buds, bark, and twigs of the prairie shrubs or any woody vegetation above the surface of the snow." Grinnell and Storer (1924, p. 226) mention this species as being crepuscular or nocturnal in forage habits.

REPRODUCTION

Very little is known concerning the breeding period and the rate of reproduction of the white-tailed jack rabbit, especially here on the western periphery of the range of the species. One female taken at Round Mound, near Lake Tahoe, Douglas County, Nevada, by Mr. James Moffitt, on June 1, 1927, contained three embryos about half developed. Fry (1924, p. 173), in speaking of this species in Sequoia National Park, may be quoted as follows: "The mating time of the animals for this locality is undoubtedly regular in the spring, as the young are usually found in June. The young range from four to six in number, and it is doubtful if more than a single litter is produced each year."

Two juvenile specimens have been examined by the writer. One of these is about half-grown, taken June 26, in the Warner Mountains, Modoc County, California, the other is not quite so large, having been taken on June 1, in the Ruby Mountains, Elko County, Nevada. Seemingly these young had been born early in the year.

The following account is given by Fry (1924, p. 174):

It was on June 21, 1907, that we found a mother snowshoe rabbit [white-tailed jack rabbit] and her young on the north spur of Mt. Silliman in Sequoia National Park, elevation 10,400 feet. The mother had

tunneled through some eighteen inches of crusted snow and built her bed on the ground under low willow bushes. When we approached, the mother rabbit bounded out on top of the snow, ran a few yards in a series of high jumps, then suddenly stopped and sat down high upon her haunches apparently in an effort to attract us from her young. We took the five young rabbits all gently from their nest, looked them over carefully, then returned them to the nest whence they came. When we were handling the young rabbits they uttered shrill squealing cries of fright and distress. In response to their cries the horrified mother ran hysterically around us uttering soft, weird, grunting sounds of emotional distress, and stamping her big padded hind feet hard down on the crusted snow with a great slapping effect. After we had taken our departure, and when away a distance of some hundred yards, the ever anxious mother was observed passing from sight under the snow to rejoin her helpless offspring.

NATURAL ENEMIES

It is probable that these rabbits are, on occasions, victims of most of the carnivores to which the black-tailed jack rabbits pay tribute.

On June 11, 1934, at an altitude of 11,900 feet near the southwest end of Lake South America, Tulare County, Mr. Joseph Dixon and Mr. William B. Richardson (MS) found evidence in the snow of a white-tailed jack rabbit's capture by a pair of red foxes (*Vulpes nector*). The tracks of the foxes and the hare were seen to come together, followed by signs of a short chase. After this only the tracks of the captors were evident.

Lepus washingtonii Baird
WASHINGTON SNOWSHOE RABBIT

Plate 2

Specific diagnosis.—Size, smallest of any of the *Lepus americanus* group; total length of adults, 363 to 417 mm.; hind legs and ears proportionately short; adults undergoing two annual molts; color in summer pelage brown; color in winter pelage white in the Sierra Nevada, although occasionally brownish in the northern cross ranges; tail relatively small, brownish-black above, dusky beneath; skull, smallest and lightest of any of the *Lepus americanus* group; rostrum slender; supra-orbital processes slender and only slightly elevated above the frontal plane; postorbital projections of supraorbitals slender throughout; jugals slender and not possessing a conspicuous dorsal flange; brain-case rather rounded; anterior palatine foramina usually somewhat constricted posteriorly; palatal bridge of medium length and usually possessing a postero-median spine; auditory bullæ rather large; molariform teeth relatively small.

Lepus washingtonii klamathensis Merriam

Plate 2, figure 1

Lepus americanus washingtoni, BRYANT (1891, p. 358).

Lepus klamathensis MERRIAM (1899, p. 100), original description.

Lepus (Poecilolagus) klamathensis, LYON (1904, p. 335).

Lepus washingtoni klamathensis, NELSON (1909, p. 107), part.

Lepus washingtonii klamathensis, KILGORE (1912, p. 164, 1916, p. 376), ORR (1933, p. 51).

Type.—Adult female, skin and skull; No. 92248, United States National Museum, Biological Survey collection; from head of Wood River, near Fort Klamath, Klamath County, Oregon; collected January 25, 1898, by B. L. Cunningham.

Geographic distribution.—The higher mountains of extreme northern California from Trinity County north also east, to and including the Warner Mountains of Modoc County (fig. 8). Life zone, Canadian, occasionally high Transition and low Hudsonian. Altitudinal range, from 3000 to 5000 feet, as known by specimens.

Diagnosis.—Size, smaller and color decidedly paler than seen in *Lepus w. washingtonii*; similar to *Lepus w. tahoensis* in summer pelage, but with less black wash over back and rump; skull, when compared with *tahoensis*, shows a greater zygomatic breadth and a shorter palatal bridge.

Adult pelage.—*Summer:* The following description is based upon an adult female, taken on July 11, at Lake of the Woods, Klamath County, Oregon. Similar to *L. w. tahoensis* but with subterminal band of guard hairs on back nearest light ochraceous-buff instead of

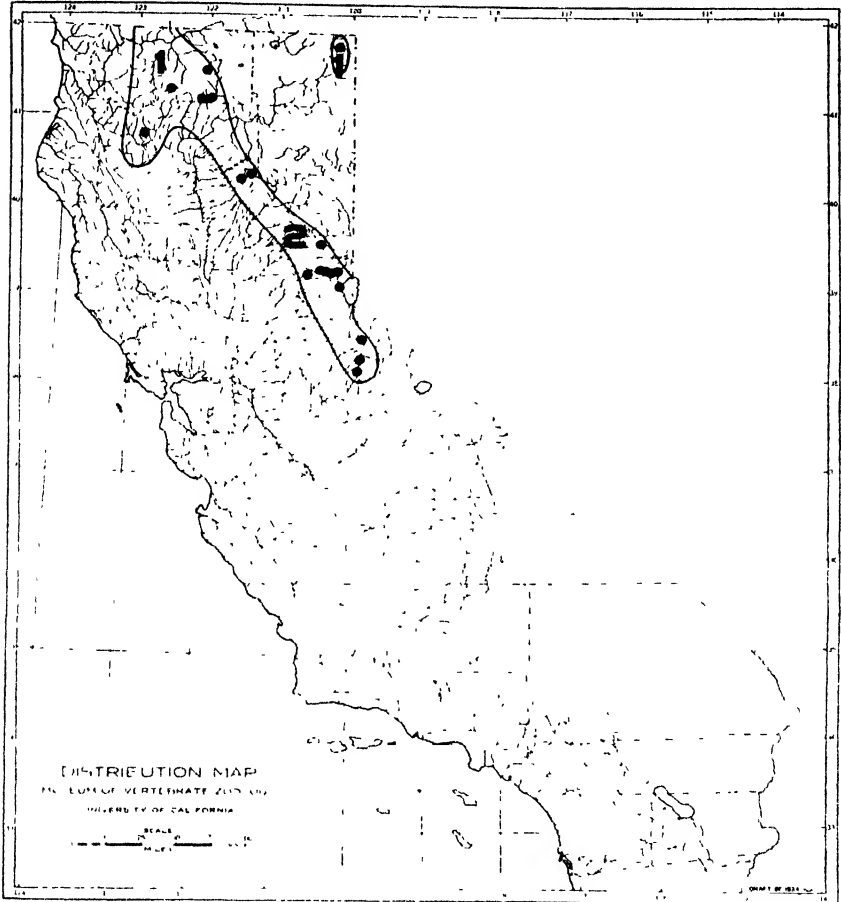


Fig. 8.—Range of the snowshoe rabbit (*Lepus washingtoni*) in California
1, *L. w. klamathensis* 2, *L. w. tahoensis*.

light pinkish-cinnamon; subterminal band of guard hairs on dorsum one-half again as long as on hairs of same region in *tahoensis*; black tipping to guard hairs of dorsal region less conspicuous than seen in *tahoensis*; color of rump nearly the same as that of back; cheeks between clay color and cinnamon-buff; tops of fore feet sometimes white, sometimes similar to top of head or even mottled with white;

tops of hind feet usually white but sometimes mottled with brown; ventral parts white only along mid-line.

Winter: Sometimes white, similar to description given for *L. w. tahoensis*. In some instances specimens taken at low elevations in winter are seen to possess a brown pelage and, even in the same locality, some rabbits of this species may be white and others brown in winter as was noted by Nelson (1909, p. 108).

One individual examined, taken in November, near Weaverville, Trinity County, California, differs in coloration from summer-taken rabbits of this race as follows: Subterminal band of guard hairs on upper parts light pinkish-cinnamon; terminal band a very dark brown instead of black; lower margins of sides and flanks vinaceous-buff; inner parts of ears white, except for a strip near the posterior borders, which is similar in color to outer, anterior parts of ears.

Juvenile pelage.—Similar to *Lepus w. tahoensis*.

Postjuvenile pelage.—No adequate material was examined representing this pelage phase.

Skull (pl. 2, figs. 1-2).—When compared with a series of *L. w. washingtonii* from near Skamokawa, Wahkiakum County, Washington, *klamathensis* was seen to differ in the following respects: size, smaller; rostrum noticeably shorter and tapering abruptly; brain-case more rounded and shorter antero-posteriorly; palatal bridge shorter; auditory bullæ relatively larger.

Remarks.—Specimens examined representing this race in Trinity County and on Butte Creek, Shasta County, compare favorably with topotypes of *L. w. klamathensis*. Two individuals from southern Siskiyou County, California, are slightly nearer this race than *tahoensis* as noted by Orr (1933, p. 55).

A single skin in the collection of the Museum of Vertebrate Zoölogy from near Fort Bidwell in the Warner Mountains, Modoc County, is tentatively referred to this race. It is, however, in white winter pelage, hence of little systematic value.

Fossil remains, supposedly representing *Lepus w. klamathensis*, are recorded from Potter Creek and Samwell caves in Shasta County by Kellogg (1912, p. 164).

Measurements.—The average and extreme measurements of 3 adult males from Klamath County, Oregon, and Trinity County, California, are as follows: Total length, 377.0 (367-387); tail vertebrae, 34.7 (26-46); hind foot, 122.7 (115-130); ear from crown (1

specimen), 87; ear from notch (1 specimen), 74; basilar length (2 specimens), 52.9–55.4; zygomatic breadth, 36.0 (35.3–36.1); postorbital constriction, 11.3 (10.5–11.8); length of nasals (2 specimens), 25.6–28.4; width of nasals, 14.9 (14.5–15.3); length of molar series, 12.7 (12.2–13.2); diameter of external auditory meatus, 4.3 (4.0–4.5); breadth of brain-case (2 specimens), 22.4–22.9; length of palatal bridge, 5.1 (4.9–5.3). The average and extreme measurements of 3 adult females from Klamath County, Oregon, and Siskiyou County, California, are as follows: Total length (2 specimens), 412–417; tail vertebrae (2 specimens), 38–17; hind foot (2 specimens), 116–120; ear from crown (1 specimen), 90; ear from notch (1 specimen), 77; basilar length (2 specimens), 54.0–56.9; zygomatic breadth (2 specimens), 37.0–37.8; postorbital constriction, 11.6 (10.5–12.3); length of nasals, 29.4 (28.0–31.0); width of nasals, 15.5 (14.4–16.2); length of molar series, 13.4 (12.9–13.9); diameter of external auditory meatus (2 specimens), 3.9–4.3; breadth of brain-case (2 specimens), 22.3–23.5; length of palatal bridge, 4.9 (4.4–5.3).

Specimens examined.—A total of 7 from the following localities: Trinity County: head of Bear Creek, 2; Rush Creek, about 3000 feet altitude, 12 miles from Weaverville, 1. Siskiyou County: Benton Estate, Butte Creek, 5000 feet altitude, 1; McCloud, 1. Modoc County: vicinity of Fort Bidwell, 1. Shasta County: 12 miles east of McCloud Post Office, 1.

***Lepus washingtonii tahoensis* Orr**

Plate 2, figures 3, 4

Lepus washingtoni klamathensis, NELSON (1909, p. 107), part.

Lepus washingtoni tahoensis ORR (1933, p. 51), original description; GRINELL (1933, p. 199).

Type.—Adult female, skin and skull; No. 38286, Museum of Vertebrate Zoology; from one-half mile south of Tahoe Tavern, Placer County, California; collected May 7, 1927, by James Moffitt; original No. M24.

Geographic distribution.—Along the Sierra Nevada of California from the region of Mt. Lassen, south, at least to Tuolumne County (fig. 8). Zonal range, mainly Canadian. Altitudinal range, from 4800 to 7000 feet.

Diagnosis.—Similar to *Lepus washingtoni klamathensis*, but in summer pelage mass effect of color darker; black tipping of hairs on

back more pronounced; conspicuous blackish rump present in contrast to the rather uniform dorsal coloration of *L. w. klamathensis*. Skull differing from that of *klamathensis* principally in the possession of a longer palatal bridge.

Adult pelage.—*Summer:* The following description is based upon an average specimen from the central Sierra Nevada region. Overhairs of dorsum light pinkish-cinnamon on subterminal bands with tips black, resulting in nearly a cinnamon-brown mass effect; subterminal band of guard hairs on top of head bright pinkish-cinnamon; strip extending along side of nose, through orbital region, to base of ear capucine buff with only slight amount of black tipping to some hairs; anterior outer portions of ears similar in color to back; posterior outer portions of ears, exclusive of rims, buffy gray, becoming almost black at tips; narrow rim of pure white extending from posterior bases of ears along external margins to tips, sometimes extending part way down anterior rims; rump heavily washed with black; tops of fore legs dull cinnamon, slightly grizzled; tops of fore feet white; lower parts of hind legs above heels pinkish-cinnamon; tops of hind feet white; top of tail similar in color to back; underside of tail dusky; white ventral coloration of body much more extensive than seen in *L. w. klamathensis*.

Winter: Terminal half of guard hairs always white with the basal half of coarser hairs also white; finer guard hairs of upper parts varying from pale pinkish-cinnamon to nearly salmon-buff on central band, becoming deep neutral gray basally; terminal band of underfur on upper parts varying from pale pinkish-cinnamon almost to salmon-buff; basal portion of underfur deep neutral gray on sides of body, becoming pure white on ventral parts; ventral pelage usually entirely white throughout; vibrissæ white with exception of proximal portion of the uppermost ones which often appear black.

Juvenile pelage.—The individual hairs of the juvenile pelage are relatively long in proportion to the size of the body. This is especially true of the guard hairs which are rather sparsely distributed. Actually, upon parts of the head and ears, the fur is longer than that normally found on adults.

The following color description is based upon a specimen taken at Mineral, Tehama County, California: terminal band of guard hairs of back and sides usually slightly paler than light pinkish-cinnamon, this band varying considerably in extent, being much

broader on the hairs situated on the sides of the body than of those on the back; occasional guard hairs seen on the back with subterminal band of light pinkish-cinnamon and terminal band either dark brown or blackish; subterminal band of most overhairs on dorsum between natal brown and bone brown, becoming mouse gray basally; under-fur of sides light mouse gray nearly throughout length of hairs with terminal band progressively reduced toward lower margins of sides, finally being absent entirely on most ventral parts of sides. Top of head similar to back, but with guard hairs more conspicuous; white "star" prominent on forehead; hairs on outer anterior and inner surfaces of ears light pinkish-cinnamon in color, these surfaces being rather heavily furred; posterior margins of ears rimmed with white; tops of fore legs and fore feet similar to back; undersides of fore feet white; tops of hind feet possessing a few guard hairs similar in color and pattern to those on the sides of the body, but on parts the pelage consists mostly of under-fur varying in color from white to pale gray; undersides of hind feet dusky; toes of hind feet rather heavily covered with guard hairs of same color as back; undersides of toes white; chin white; chest similar in color to sides; ventral parts mostly white; tail dusky beneath; vibrissæ black except for lower ones which are white.

Postjuvenile pelage.—Material lacking representing this phase of pelage, but probably quite similar to juvenile pelage with greater proportion of guard hairs present.

Skull (pl. 2, figs. 3, 4).—Similar to that of *Lepus w. klamathensis*, differing from it chiefly in the possession of a longer palatal bridge. Other less marked differences distinguishing this race from *klamathensis* are seen in its lesser zygomatic breadth, broader brain-case, larger external auditory meatus, and more prominent postero-median spinous process of palate.

Remarks.—The southernmost record for this species is Niagara Creek, Tuolumne County, California. At this locality a dead individual was seen and photographed by Mr. Joseph Dixon (MS) on August 30, 1924. There is no doubt as to the identity of this animal since the picture, taken at close range, clearly is that of a snowshoe rabbit.

Measurements.—The average and extreme external measurements of 5 adult males from Placer County are as follows: Total length, 382.0 (363–396); tail vertebrae, 28.9 (26.0–37.0); hind foot, 117.4 (112–124); ear from crown, 95.5 (92–99). The average and extreme

cranial measurements of 9 adult males from Placer County are as follows: Basilar length, 54.8 (53.6–56.5); zygomatic breadth, 35.7 (34.7–36.4); postorbital constriction, 11.0 (9.4–12.1); length of nasals, 27.9 (26.5–29.2); width of nasals, 14.9 (13.0–15.8); length of molar series, 12.8 (12.2–13.5); diameter of external auditory meatus, 5.0 (4.6–5.3); breadth of brain-case (8 averaged), 23.6 (23.2–23.9); length of palatal bridge, 6.3 (5.7–6.6). The average and extreme external measurements of 4 adult females from Placer, Sierra and Nevada counties are as follows: Total length (3 averaged), 392.7 (383–400); tail vertebrae, 33.8 (25–40); hind foot, 129.0 (125–132); ear from crown (3 averaged), 101.3 (97–106); ear from notch (2 specimens), 76–78. The average and extreme cranial measurements of 6 adult females from Placer, Sierra and Nevada counties are as follows: Basilar length, 55.8 (54.6–57.5); zygomatic breadth, 35.7 (34.3–36.9); postorbital constriction, 10.7 (10.0–11.4); length of nasals, 28.4 (27.1–29.5); width of nasals, 15.0 (14.5–16.0); length of molar series, 13.1 (12.2–13.6); diameter of external auditory meatus, 4.8 (4.4–5.0); breadth of brain-case (4 averaged), 23.9 (22.7–25.0); length of palatal bridge, 6.2 (5.6–6.8).

Specimens examined.—A total of 30 from the following localities: Tehama County: Mineral (vicinity), 3. Plumas County: Willow Lake, 5600 feet altitude, 1. Sierra County: east side of Yuba Pass, 6000 feet altitude, 1. Nevada County: Spruce, 1; 10 miles west of Truckee, 1; Truckee, 1. Placer County: Donner Summit, 1; Cisco, 1; near Tahoe City, 19. Alpine County: Pacific Valley, between Woodfords and Big Trees, 1.

LIFE HISTORY

HABITAT

In California the snowshoe rabbit occupies an ecologic niche within the Boreal life zones which is almost the counterpart of that of the brush rabbit in the lower, Austral chaparral belt. It is an inhabitant of riparian growth, such as alder and willow, dense thickets of young conifers (fig. 10), especially firs whose basal branches often droop to the ground, and clumps of chaparral made up principally of various species of *Ceanothus* and *Arctostaphylos* (fig. 9). In this respect it is quite like (*Lepus bairdii*) of eastern Oregon (*cf.* Orr, 1934, p. 153).



Fig. 9—Cover such as provides shelter for snowshoe rabbits, two miles south of Tahoe City, Placer County, California. Photograph taken by Mr. James Moffitt, September 28, 1932



Fig. 10 - Thickets of firs are often selected for habitation by snowshoe rabbits, especially in winter, near Tahoe City, Placer County, California. Photograph taken by Mr. James Moffitt, March, 1927.

Near Lake Tahoe, in Placer and El Dorado counties, in the summer of 1931, the writer observed signs of these rabbits only near brush surrounding meadows and close to riparian growth. There were no indications of the presence of members of this species on the tops or upper slopes of brush-covered ridges. One individual noted at Miller Lake, Placer County, was near a clump of willows and alders which grew on the lake shore. The surrounding forest consisted of lodgepole pine (*Pinus contorta*), red fir (*Abies magnifica*) and aspen (*Populus tremuloides*). Grinnell, Dixon and Linsdale (1930, p. 514) found this species inhabiting similar situations in the Lassen region, as follows: "Snowshoe rabbits were encountered, though not frequently, among snow-brush thickets and small firs and in or near thickets of alders or willows in meadows."

Dice (1926, p. 8), referring to this species in southern Oregon, states that individuals were noted only in patches of buck-brush (*Ceanothus velutinus*) where Douglas fir and cedar saplings were scattered about.

GENERAL HABITS AND BEHAVIOR

As is true of other members of the genus *Lepus*, this species has never been found to inhabit burrows. It has generally been assumed that forms, situated in dense clumps of vegetation, are occupied during resting hours.

Unfortunately, but little opportunity was had during this study to make observations on the habits and behavior of Washington snowshoe rabbits. While driving along a road in Placer County, California, shortly before sunset on July 22, 1931, a single individual was seen feeding on the road. To all external appearances the animal was unmindful of the car, which was brought to a stop about twenty yards distant as it continued feeding. During the ensuing ten minutes it scarcely moved more than a few feet. Upon hearing any unusual sound the rabbit would raise its head and cease chewing. When the machine was started it hopped in a somewhat leisurely fashion into a thicket of alders and willows alongside the road.

At 5:00 P.M. on April 11, 1927, about three-fourths of a mile south of Tahoe Tavern, Placer County, tracks of a snowshoe rabbit were seen on fresh snow among some willows in a small meadow (Moffitt, MS). After following the tracks a short distance through the willow bushes a rabbit was seen. When an approach was made to within

eight feet of the animal it became uneasy and hopped a short distance. After observing it a minute or two it was shot. Two hundred yards farther on a second snowshoe rabbit was seen on a small patch of bare ground just above a six-foot bank along the shore of Lake Tahoe. This individual became startled and ran down the bank where it was seen to take refuge among some tree roots.

FOOD HABITS

No information is at hand concerning the food habits of this species. It is probable, however, that a large number of different annual plants are eaten during the summer months as is true of most other members of this group. When the ground is snow-covered in winter it is more likely that evergreen shrubs and possibly the bark of certain deciduous trees such as aspen, alder and willow, constitute the major foods for snowshoe rabbits. At 6:00 P.M. on July 22, 1931, a single individual of this species was observed near Miller Lake, Placer County, California, eating manure in the middle of a road. So far as known feeding takes place during the evening and early morning hours.

REPRODUCTION

The breeding period for this species extends from early spring to late summer, with the number of young per litter varying from two to six.

Grinnell, Dixon and Linsdale (1930, p. 544) record two pregnant females taken in the Lassen area on June 22, and July 22, 1924, respectively, each containing five embryos. These authors also record two juveniles collected in the same region, one weighing 132.5 grams, taken on July 7, 1925; the other weighing 320 grams, taken on June 19, 1924. Mr. James Moffitt collected a young snowshoe rabbit less than one-fourth grown near Tahoe City, Placer County, California, on June 20, 1929, and on May 7, 1927, at this same locality a female containing "at least three small embryos."

An adult female taken on August 21, on Butte Creek, Siskiyou County, California, gave evidence of having suckled young, by the presence of active mammary glands (H. G. White, MS). Another specimen examined, from the head of Bear Creek, Trinity County, captured on August 15, is about one-third grown. On June 5, a female was collected from the east side of Yuba Pass, Sierra County,

which, from the condition of the mammary glands, was judged to be suckling young.

Three young snowshoe rabbits were found by Mr. Rodger Barker (*vide* Dr. Gayle Pickwell, in letter of November 2, 1934) beneath a shallow pile of brush at Fallen Leaf Lake, El Dorado County, California. The young were in a cavity six inches in diameter which ran back about two feet behind the small pile of brush (*Ceanothus velu-*

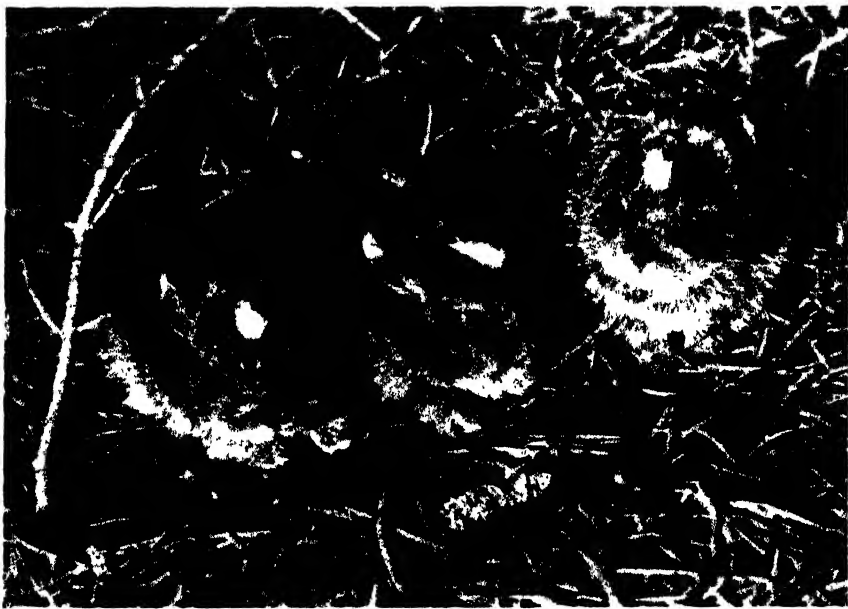


Fig. 11 — Three very young snowshoe rabbits on a bed of fir needles, near the south end of Fallen Leaf Lake, El Dorado County, California. Photograph taken by Dr. Gayle Pickwell, June 26, 1934

tinus). The cavity was entirely unlined. The general plant covering in this vicinity consisted of white fir and Jeffrey pine, rather closely spaced, with occasional clumps of *Ceanothus velutinus*. The young were discovered on June 24 or 25, 1934. On June 26, when sought for photographing (see fig. 11), two of them were still in the brush but the third was some distance away.

It appears probable that no definite nest is constructed. Grange (1932a, p. 7) failed to find any when studying the Eastern varying hare (*Lepus americanus*), which is closely related to the present species and similar in many habits.

Scheffer (1933, p. 78) made the following observations on the

breeding activity of *Lepus washingtonii* in the Puget Sound region of Washington over a period of two summers:

- May 5. A litter of three born in captivity. Two of these subsequently died, but the third was reared on a bottle.
- May 12. A female that did not survive confinement in the box trap overnight was found to contain five well-developed embryos.
- May 15. A litter of six was born in an enclosed yard with other rabbits, and none survived the night of their birth.
- May 16. Five baby rabbits, perhaps two or three days old, were found in a brush pile, in a swampy bit of meadow and brought to us by a cooperator.
- May 18. Post-mortem examination of a female that had died in captivity disclosed five embryos about three and a half inches long.
- May 20. The same cooperator who procured for us the lot of baby rabbits on May 16 brought us another lot of four from the same swampy meadow.
- May 25. A female died shortly after being taken from the box trap, apparently from the stress of untoward plight and fear which is common to some animals when trapped. Post-mortem showed five well-developed embryos, about three and a quarter inches long.
- June 10. A female in captivity gave birth to two young.
- July 4. A litter of three were born in captivity, all of them surviving, with others, for several weeks at least.

This same author (Scheffler, *loc. cit.*) says: "The young are precocious, in the biological sense, being born well furred, with their eyes open, and are able to hop about."

NATURAL ENEMIES

No definite instances can be cited wherein snowshoe hares in California have been subject to the attacks of carnivores. It is doubtless true, however, that coyotes (*Canis latrans*) and bobcats (*Lynx rufus*) are important enemies, particularly in winter. Grinnell, Dixon and Linsdale (1930, p. 475) noted that at this season near Mineral, Tehama County, California, bobcat tracks were seen in the snow, "where footprints of snowshoe rabbits were thickest." Various species of hawks and owls may also prey upon members of this species

Lepus californicus Gray
BLACK-TAILED JACK RABBIT

Plates 3, 4

Specific diagnosis.—Size, large with total length of adults varying from 520 to 630 mm.; hind legs and ears relatively long; adults having only one annual molt; tail relatively large with a black median-dorsal stripe and buff or grayish beneath; skull relatively long and slender; rostrum long and tapering; supraorbital processes broad, especially the posterior extensions of the processes, and somewhat elevated above the frontal plane; jugals rather narrow without a conspicuous flange projecting outward, laterally, from their dorsal margins; brain-case long and slender; anterior palatine foramina usually possessing a slight posterior constriction; palatal bridge relatively short and lacking a conspicuous postero-medial spine; auditory bullae varying from relatively small to large; molariform teeth small.

Lepus californicus californicus Gray

Plate 3, figure 1; Plate 4, figure 1

Lepus californicus GRAY (1836, p. 88), *nomen nudum*.

Lepus californicus GRAY (1837, p. 586), original description.

Lepus californicus, WATERHOUSE (1848, p. 131), part.

Lepus californicus californicus, NELSON (1909, p. 129).

Lepus californicus vigilax Dice (1926, p. 11).

Lepus californicus californicus, GRINELL, DIXON and LINSDALE (1930, p. 545).

Type.—No. 53.8.29.30, British Museum: from "St. Antoine, California," probably from the coastal slopes of the mountains west of Mission San Antonio near Jolon, Monterey County (*vide* Nelson, 1909, p. 129); collected by David Douglas, May, 1831.

Geographic distribution.—From the Oregon line in the northwestern part of California, south along the coast as far as Santa Barbara County; inland, diagonally, from northwestern Siskiyou County to the upper Sacramento Valley and from here south, both on the valley floor and along adjacent lower mountain slopes, to the northern part of the San Joaquin Valley and lower Salinas Valley (fig. 12). Zonal range, Lower Sonoran to Transition. Altitudinal range, from sea level to 4800 feet.

Diagnosis.—Size, large; color dark with pelage harsh in texture; skull, large with rostrum relatively long and broad at base and with

auditory bullæ actually smaller than those possessed by any other race of this species in California.

Adult fall pelage.—The following description is based upon an average specimen from Tehama County, California, taken during December. Subterminal band of guard hairs on top of head, back

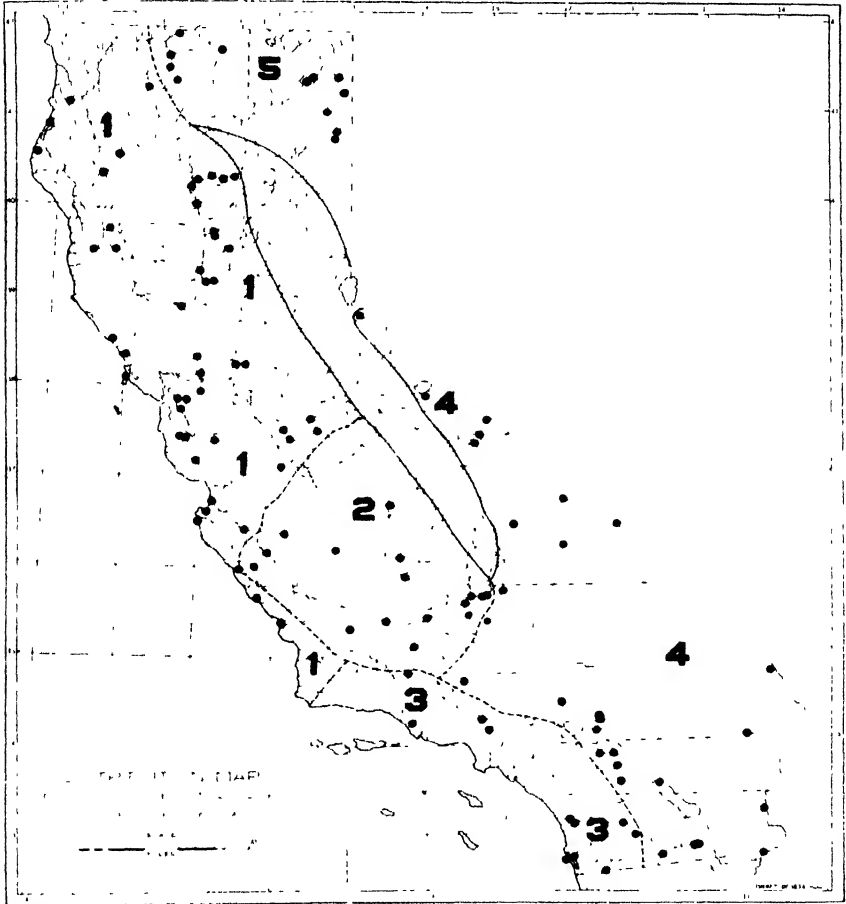


Fig. 12.—Range of the black-tailed jack rabbit (*Lepus californicus*) in California. 1, *L. c. californicus*; 2, *L. c. richardsoni*; 3, *L. c. bennettii*; 4, *L. c. deserticola*; 5, *L. c. wallacensis*.

and anterior parts of flanks light pinkish-cinnamon with basal portion pale gull gray; apical band of black proportionately long on these hairs; rump slightly lighter than back, due to reduced apical band of black; top of tail black with this color extending as a narrow, median band a short distance up on rump; terminal band of guard

hairs on both sides and under part of tail nearly light ochraceous-buff; anterior, outer portions of ears similar to top of head in color (perhaps slightly more yellowish), but more finely grizzled due to shortness of pelage; tips of ears black, both inside and out, but with extent of black greater near outer, posterior margins where it usually extends more than one-third of distance from tip to base; anterior rims of ears margined with moderately long, buffy hairs, most of which possess a slight amount of black pigment at their tips; inner posterior parts of ears scantily haired, with color of hairs varying from gray and buffy in central and basal parts to cinnamon-buff near tips of ears and with hairs in central portions, within one-half inch of margins, grizzled not unlike outer parts; hairs along inner posterior margins of ears varying from white at base of ears to buffy distally; outer posterior parts of ears sparsely covered with whitish hairs, except at tips; nape dusky; area extending from sides of nose nearly to orbital regions grayish, due to nearly white subterminal band and black apical band possessed by guard hairs; circumorbital rings light buffy; eyelashes black; vibrissae both black and white and various combinations thereof; sides of body lighter than back due entirely to much reduced apical band of black on guard hairs; basal portions of hairs on sides of body deep gull gray; tops and outer sides of fore legs slightly paler than pinkish cinnamon with a small amount of black tipping present on most of hairs; tops of fore feet much paler in color than tops of fore legs; tops of hind feet whitish; guard hairs on chest varying from light pinkish cinnamon to pinkish cinnamon.

Juvenile pelage.—Individuals in this pelage, representing 4 out of the 5 races (excepting *L. c. bennettii*) of this species studied, were examined. While the subspecific color differences are not as marked as seen in adult pelages of these races, there is, nevertheless, a noticeable difference between the most extremely colored forms. In general, the juvenile pelage of *californicus* is more yellowish in tone than that of the adults, with the subterminal band of the overhairs on the upper parts being nearly pinkish buff. Specimens representing *richardsonii* from southern Tulare and southwestern Kern counties show only a slightly paler subterminal band on the overhairs of the upper parts than do those of typical *californicus*. Juveniles of the races *deserticola* and *wallawalla* possess a very pallid subterminal band which is nearly white. The dark under-fur showing through in

this pelage, however, results in a darker mass effect than seen in adult pelage.

Postjuvenile pelage.—Similar in general to that of adults but paler.

Skull (pl. 3, fig. 1; pl. 4, fig. 1).—Large and massive in structure for most part; rostrum relatively long, tapering from a broad base; zygomata broadly expanded; jugals proportionately slender; supra-orbital processes large with the postorbital extensions very broad; palatal bridge of medium length; auditory bullæ small.

Lepus c. californicus is distinguished cranially from *L. c. richardsoni* by its larger size, relatively greater zygomatic breadth, longer rostrum, longer palatal bridge, lighter jugals and smaller auditory bullæ.

Remarks.—*Lepus c. californicus* represents the largest and darkest colored race of this species in California. The most intense pigmentation is exhibited by specimens from the northern part of the Sacramento Valley and from the coast ranges to the west, whereas, inland to the southward in the great valley there is a gradual change to the paler color of *richardsoni*. Along the immediate vicinity of the coast this change toward more pallid coloration is not so evident. Skins from coastal San Luis Obispo County are very similar in color to those from the northwest coast of California. A series of jack rabbits from Seaside, Monterey County, near the mouth of the Salinas River, possess a slightly paler color, in general, than is characteristic of specimens from other localities along the coast. Farther south in the Salinas Valley, near Soledad, a still paler color is evident on the subterminal band of the dorsal guard hairs and on the terminal band of the ventral guard hairs—a condition which is intermediate between that of *californicus* and *richardsoni*.

The large size possessed by *californicus* is maintained fairly uniformly throughout the greater part of its range in northern California and along the coast south to San Luis Obispo County. At the southern end of the Sacramento Valley a trend toward smaller size is perceptible and in the northern part of the San Joaquin Valley a considerable change in this direction is evident. The average basilar length of 6 adult males, from San Joaquin and Stanislaus counties, is 72.1 mm. as compared with 75.2 mm. for 17 adult males from northern California. Similarly, specimens from this same area are characterized, cranially, by the possession of relatively shorter nasals and a narrower zygomatic breadth as compared with those from farther

north, the ratio of length of nasals to basilar length being 54.7 per cent and the ratio of the zygomatic breadth to basilar length being 57.1 per cent. As may be seen on comparing these figures with those given in Table 2, the length of the nasals for these specimens is intermediate between the averages for typical *californicus* and *richardsonii*, and the zygomatic breadth is nearly as narrow, relatively, as seen in the latter race. Seven adults from Alameda, San Mateo, and Santa Clara counties, in the San Francisco Bay region, while averag-

TABLE 2

CRANIAL RELATIONSHIPS EXPRESSED IN PERCENTAGES FOR THE VARIOUS RACES OF
Lepus californicus OCCURRING IN CALIFORNIA

	Ratio of zygomatic breadth to basilar length		Ratio of length of nasals to basilar length		Ratio of width of nasals to length of nasals		Ratio of palatal length to basilar length		Ratio of length of molar series to basilar length	
	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀
<i>L. c. californicus</i>	58.6	59.0	56.3	56.4	51.3	49.4	8.5	8.1	21.9	21.9
<i>L. c. richardsonii</i>	56.8	57.0	52.3	53.8	50.4	47.9	8.1	7.9	21.9	21.8
<i>L. c. bennettii</i>	58.6	58.5	54.6	53.7	46.8	46.8	8.5	8.1	22.0	21.9
<i>L. c. deserticola</i>	56.8	57.4	51.8	50.5	47.3	48.8	8.2	8.8	21.8	22.2
<i>L. c. wallawalla</i>	58.3	58.7	51.5	52.6	48.0	47.2	8.9	9.0	22.6	21.7

ing larger in body measurements than the northern San Joaquin Valley specimens, are quite similar to the latter with respect to length of nasals and zygomatic breadth, the ratio of length of nasals to basilar length being 54.9 per cent, and that of zygomatic breadth to basilar length being 57.4 per cent.

The small-sized auditory bullæ, typical of *californicus* from the northern Sacramento Valley and northwest coast ranges are maintained constantly south along the coast to Marin County. South of San Francisco Bay the auditory bullæ are nearly as large as seen in *richardsonii*. The change in this character is more gradual in the Sacramento Valley from small size at the north end to a condition closely approaching *richardsonii* at the north end of the San Joaquin Valley. It must be kept in mind, however, that while the auditory bullæ of specimens from San Francisco south along the coast to San Luis Obispo County are actually nearly as large as those of *richardsonii* from the northern San Joaquin and Salinas valleys, they are relatively much smaller, due to the proportionately greater basilar length of the skulls of these coastal specimens. Specimens from the

vicinity of Soledad, in the Salinas Valley, are intermediate in most respects between *californicus* and *richardsonii*, but in color approach nearer the former race.

In view of the fact that a gradual change is apparent, in respect to all subspecific characters studied, from the larger and darker race *californicus* to the smaller, paler, more southerly distributed race *richardsonii*, I hardly think the name *vigilax*, proposed by Dice (1926, p. 11), need necessarily be applied to jack rabbits from the northern Sacramento Valley. The type locality of *Lepus californicus*, unfortunately, is situated in an area of intergradation, as is also the type locality of *richardsonii*, which is but a short distance east of this point (near Jolon, Monterey County). However, we should not look upon specimens from these two type localities as typical of either race, but rather as intergrades coming slightly nearer their respective races. Each of these subspecies reaches an optimum, in regard to most of its subspecific characters, a long distance from its type locality. *Lepus c. californicus* reaches this peak of its racial differentiation in the northern Sacramento Valley region. For this reason, I here concur with the opinion held by Grinnell, Dixon and Linsdale (1930, p. 547) concerning *Lepus californicus vigilax* Dice, and consider it as synonymous with *Lepus californicus californicus* Gray.

Measurements.—The average and extreme measurements of 17 adult males from Trinity, Tehama and Butte counties are as follows: Total length (16 averaged), 588.1 (556–610); tail vertebrae (16 averaged), 92.5 (70–112); hind foot, 133.6 (118–144); ear from notch (4 averaged), 134.2 (129–143); ear from crown (11 averaged), 161.8 (151–173); basilar length, 75.2 (71.9–77.4); zygomatic breadth, 44.1 (42.0–46.8); postorbital constriction, 13.0 (11.5–15.1); length of nasals, 42.3 (40.5–44.9); width of nasals, 21.7 (19.6–23.7); length of molar series, 16.5 (15.6–17.5); diameter of external auditory meatus, 5.7 (5.0–6.4); breadth of brain-case, 27.8 (26.3–29.1); length of palatal bridge, 6.4 (5.4–7.7). The average and extreme measurements of 11 adult females from Tehama and Butte counties are as follows: Total length, 607.3 (573–630); tail vertebrae (10 averaged), 94.8 (76–110); hind foot (10 averaged), 132.5 (120–143); ear from notch (4 averaged), 134.0 (129–138); ear from crown (9 averaged), 158.8 (152–165); basilar length, 74.3 (70.8–78.0); zygomatic breadth, 43.9 (41.8–46.7); postorbital constriction, 12.7 (11.8–14.5); length of nasals, 41.9 (37.3–44.3); width of nasals, 20.7 (19.4–22.8); length of molar series,

16.3 (15.2–17.8); diameter of external auditory meatus, 5.5 (4.9–6.0); breadth of brain-case, 28.1 (27.1–29.5); length of palatal bridge, 6.0 (5.3–6.9).

Weights.—The average and extreme weights of 10 adult males from Trinity, Tehama, and Butte counties are as follows: 2453.8 (1685–2823) grams. The average and extreme weights of 9 adult females from Tehama and Butte counties are 2870.6 (2564–3146.3) grams.

Specimens examined.—A total of 143 from the following localities: Siskiyou County: Callahan, Scott River, 2. Humboldt County: 3 miles west of Arcata, 1; Coyote Peak, 3000 feet altitude, 1; Ferndale, 2. Trinity County: South Fork Mountain, 2700–5500 feet altitude, 6; Haylork, 1. Tehama County: 1 mile northeast of Red Bluff, 300 feet altitude, 5; Red Bluff (coll. Calif. Acad. Sci.), 3; Dale's on Paines Creek, 600 feet altitude, 6; Inskip Hill, 1800 feet altitude, 1; Lynans, northwest of Lyonsville, 3300 feet altitude, 1; Battle Creek Meadows, 4800 feet altitude, 1; Mill Creek, 2 miles northeast of Tehama, 1. Mendocino County: Sherwood (3 in coll. Calif. Acad. Sci.), 4; 3 miles south of Covelo, 3; 3 miles west of summit of Mt. Sanhedrin, 1. Butte County: Butte Creek, 4 miles southeast of Chico, 1; east side of Sacramento River, southwest of Chico, 8; Dry Creek, Oroville-Chico Road, 2; Chambers Ravine, 4 miles north of Oroville, 1; Butte Creek, 10 miles west of Gridley (coll. Ralph Ellis, Jr.), 2. Colusa County: 3 miles west of Stonyford, 800 feet altitude, 1; 8 miles north of Colusa, 2. Sutter County: Marysville Buttes, 3–4 miles northwest of Sutter, 3; Butte Slough, 1 mile west of West Butte, 2; Butte Creek, 6 miles north of Meridian (collection Ralph Ellis), 2. Sonoma County: Freestone, 1; 7 miles west of Cazadero, 2; southwestern Sonoma County, 1. Yolo County: Rumsey, 1; Esparto, 1. Solano County: 3 miles west of Vacaville, 1; Grizzly Island (3 in collection Ralph Ellis), 5. Sacramento County: 1½ miles north of Walnut Grove, 1. Marin County: Bolinas Bay (collection Ralph Ellis), 3; 3 miles west of Inverness, 1. Contra Costa County: 2 miles southwest of Walnut Creek, 1; west side of Mt. Diablo, 1. Alameda County: Berkeley Hills, 1; Bay Farm Island, 1. Santa Clara County: Palo Alto, 1; Menlo Park, 8; Alum Rock Park (coll. Calif. Acad. Sci.), 1; Los Gatos (coll. Calif. Acad. Sci.), 1. San Joaquin County: Trigo, 2 miles south of Farmington, 9; Tracy Lake, 6 miles southwest of Galt, 1. Stanislaus County: near La Grange, 2; Turlock, 6. Merced County:

Snelling, 250 feet altitude, 1; Delhi, 1; Los Banos, 1; 10 miles east of Los Banos (collection Ralph Ellis), 3. Monterey County: Carmel Point (1 in coll. Calif. Acad. Sci.), 4; near Soledad, 4. San Benito County: Hernandez, 2. San Luis Obispo County: Morro, 1; San Simeon, 3.

***Lepus californicus richardsonii* Bachman**

Plate 3, figure 4; Plate 4, figure 2

Lepus richardsonii BACHMAN (1839, p. 88), original description.

Lepus californicus, AUDUBON and BACHMAN (1854, p. 53), part.

Lepus tularensis MERRIAM (1904*b*, p. 136).

Lepus richardsoni, MERRIAM (1904*b*, p. 136).

Lepus campestris richardsoni, ELLIOT (1905, p. 363).

Lepus californicus richardsoni, NELSON (1909, p. 133).

Lepus californicus richardsonii, MILLER (1912, p. 353).

Type.—No. A 586, Zoölogical Society collection, London (type no longer extant); probably from near Jolon, Monterey County, California; collected by David Douglas, 1831.

Geographic distribution.—The central and southern parts of the San Joaquin Valley and lower slopes of the adjacent mountains, occurring also in the upper Salinas Valley (fig. 12). Zonal range, mainly Lower and Upper Sonoran. Altitudinal range, from valley floor (slightly above sea level) to over 3000 feet.

Diagnosis.—Size, small; color, pale with pelage somewhat finer in texture than seen in *L. c. californicus*; skull, small but rather heavily constructed with rostrum of medium length and relatively broad at base; auditory bullæ of medium size.

Adult fall pelage.—The following description is based upon a specimen from Kern Lake Basin, Kern County, California. Intermediate between *californicus* and *deserticola*; subterminal band of guard hairs on top of head and anterior margins of flanks slightly paler than pinkish buff; apical band of black on these hairs of medium length, shorter than seen on specimens of *californicus* from the northern Sacramento Valley; terminal band of guard hairs on sides and under part of tail pale pinkish-buff; area of black on tips of ears less extensive than seen in *californicus*, likewise, color of hairs on inner posterior parts of ears paler; tops and outer sides of fore legs near light ochraceous-buff with a slight amount of black tipping on most of hairs; subterminal and, in many instances, terminal band of guard hairs on chest between light ochraceous-buff and pinkish-

buff; guard hairs on ventral parts of body varying from nearly white to light ochraceous-buff.

Skull (pl. 3, fig. 2; pl. 4, fig. 2).—Small, although rather heavily constructed; rostrum rather short although relatively broad at base; zygomata not widely expanded; jugals broader than in *californicus*; supraorbital processes somewhat smaller than in *californicus* with frontal area more depressed; palatal bridge short; auditory bullae of medium size.

This race chiefly differs, with respect to cranial characters, from *deserticola* as follows: rostrum relatively longer and broader at base, jugals narrower, palatal bridge shorter and auditory bullae smaller.

Remarks.—*Lepus c. richardsonii* represents a race whose range occupies an area of transition between two extreme areas of development in California, namely, the northern Sacramento Valley region (including adjacent mountain ranges) and the southeastern deserts. Consequently, in characters it is found to be intermediate between the extremes of development within the species expressed in the races *Lepus c. californicus* and *L. c. deserticola*. Among the characters possessed by *richardsonii* which may be included under this category are: color, length of rostrum, and size of auditory bullae. In certain other respects *richardsonii* approaches nearer the race with which it contacts either to the north or to the south. Thus in the possession of a relatively broad base to the rostrum *richardsonii* more nearly resembles *californicus*. On the other hand, in external measurements, basilar length and relative zygomatic breadth, the southern San Joaquin Valley race is indistinguishable from *deserticola*.

The cranial features possessed by *richardsonii* are maintained fairly uniformly throughout the central and southern parts of the San Joaquin Valley. In color, however, there is a continued change from a dark type, approaching *californicus*, at the northern limits of the range of the race to a pale pinkish tone, not unlike that seen in *deserticola*, at the southern margins of the San Joaquin Valley and in the Cuyama and upper Salinas valleys. Specimens from the two latter areas are slightly more pinkish in tone of color than those from the southern San Joaquin region.

Three adults in fresh fall pelage from Jolon, Monterey County, approximately the type locality of this race, are intermediate in many cranial characters between *richardsonii* and *californicus*, in this respect not being unlike specimens from Soledad, Monterey

County, which were referred to the latter race. In color they are, nevertheless, definitely nearer the more southern form. Skins from San Lucas, Monterey County, are even more pallid in coloration.

Measurements.—The average and extreme measurements of 16 adult males from Huron, Fresno County, are as follows: Total length, 538.8 (508–560); tail vertebrae, 90.2 (75–100); hind foot, 123.0 (114–127); ear from crown, 152.3 (146–160); basilar length, 70.6 (68.2–75.8); zygomatic breadth, 40.1 (38.7–41.3); postorbital constriction, 12.0 (10.4–13.2); length of nasals, 36.9 (35.0–39.4); width of nasals, 18.6 (17.3–19.8); length of molar series, 15.5 (14.7–16.5); diameter of external auditory meatus, 5.4 (4.9–5.8); breadth of brain-case, 26.8 (26.0–27.9); length of palatal bridge, 5.7 (4.1–6.9). The average and extreme measurements of 11 adult females from Huron, Fresno County, are as follows: Total length, 557.2 (533–585); tail vertebrae, 89.9 (75–100); hind foot, 123.0 (119–126); ear from crown, 154.0 (147–158); basilar length, 70.6 (68.5–73.5); zygomatic breadth, 40.3 (38.1–42.0); postorbital constriction, 12.3 (10.7–14.3); length of nasals, 38.0 (35.9–40.2); width of nasals, 18.2 (16.7–20.0); length of molar series, 15.1 (14.8–16.0); diameter of external auditory meatus, 5.4 (5.0–5.8); breadth of brain-case (10 averaged), 27.0 (25.9–28.6); length of palatal bridge, 5.6 (5.1–6.4).

Weights.—The average and extreme weights of 16 adult males from Huron, Fresno County, are 2100 (1900–2500) grams.

Specimens examined.—A total of 95 from the following localities: Monterey County: near San Lucas, 4; Jolon, 3; 1¼ miles south of Chalk Peak, 3000 feet altitude, 1; 2 miles east of Byron, 1. San Luis Obispo County: 2 miles south of San Miguel, 2; Carrizo Plains, 7 miles southeast of Simmler, 1. Fresno County: Minkler, 2; 4 miles southwest of Fresno (collection Ralph Ellis), 1; Huron, 40. Tulare County: Tipton, 260 feet altitude, 3; Fairlaim, 280 feet altitude, 9. Kern County: 8 miles northeast of Bakersfield, 3; Kern River near Bodfish, 2400 feet altitude, 1; Kern River, at Isabella, 2500 feet altitude, 2; Weldon, 2650 feet altitude, 1; Onyx, 2750 feet altitude, 1; Thompson Valley, Walker Basin, 1; 5 miles west of 12 miles south of Bakersfield, 1; Buttonwillow (coll. Calif. Acad. Sci.), 16; Kern Lake Basin (collection Ralph Ellis), 2.

***Lepus californicus bennettii* Gray**

Plate 3, figure 3; Plate 4, figure 3

Lepus bennettii GRAY (1844, p. 35), original description.*Lepus californicus*, WATERHOUSE (1848, p. 131), part.*Lepus californicus bennetti*, NELSON (1909, p. 136).*Lepus californicus bennettii*, MILLER (1912, p. 354).

Type.—No. 233a, Register 1842, British Museum; from San Diego, San Diego County, California; collected by Captain Sir Edward Belcher.

Geographic distribution.—From southern Santa Barbara and northern Ventura counties south along the coast to the Mexican boundary; extends inland to the western base of the coast ranges (fig. 12). Zonal range, mainly Upper Sonoran. Altitudinal range, from sea level up to 6000 feet.

Diagnosis.—Somewhat similar to *L. c. californicus* in color but pelage slightly finer in texture and body smaller; skull, moderately small with rostrum of medium length and relatively narrow at base; auditory bullæ of medium size.

Adult fall pelage.—The following description is based upon specimens from coastal San Diego County. Very similar in color to *Lepus c. californicus* from the northern Sacramento Valley but subterminal band of guard hairs on back, top of head and anterior parts of flanks slightly paler than light pinkish-cinnamon; black on tips of ears slightly more restricted; subterminal band of guard hairs on tops of fore feet pinkish-buff with extensive terminal band of black present; tops of hind feet, likewise, much darker than in *californicus*, being buffy instead of whitish.

Skull (pl. 3, fig. 3; pl. 4, fig. 3).—Small, although relatively heavy in proportions, as seen in *L. c. californicus*; rostrum of medium length, but proportionately narrow at base; zygomata widely expanded; jugals fairly slender; supraorbital processes small; palatal bridge relatively short; auditory bullæ of medium size.

This race may be distinguished, cranially, from *Lepus c. californicus* by its smaller size, narrower rostrum and larger auditory bullæ. It differs from *L. c. richardsonii* in that the rostrum is narrower, especially at the base, and the zygomata are more broadly expanded.

Remarks.—The northern-most specimen of this race examined is from Mt. Pinos, Ventura County; only one adult being available

from this locality. Although this individual is in worn pelage it shows the dark coloration of the coastal form rather than the pallid tones of *richardsonii*. In skull measurements it, likewise, shows relationship to *bennettii* in that it possesses a relatively slender rostrum and widely expanded zygomata.

From Ventura County south, along the coast, to northern Lower California the color of *bennettii* is maintained uniformly without change. Material is lacking, for the most part, from critical localities back from the sea coast in the coastal ranges where there is probably a trend toward more pallid coloration. Specimens examined, in worn pelage, from San Felipe Valley and Vallecitos, San Diego County, are nearly as pale, dorsally, as seen in *deserticola*. However, along the lower margins of the sides and on the ventral parts, where fading is less apt to occur, they exhibit much of the bright color seen in typical *bennettii*. These specimens are more nearly allied to the coastal race in cranial characters, possessing long rostra and small auditory bullæ.

Measurements.—The average and extreme measurements of 3 adult males from Los Angeles and San Diego counties are as follows: Total length, 553.3 (530–570); tail vertebrae, 80.0 (80–80); hind foot, 126.0 (120–138); ear from crown (2 specimens), 142–153; basilar length 69.2 (66.5–72.0); zygomatic breadth, 40.6 (39.3–41.6); post-orbital constriction, 12.0 (11.4–12.9); length of nasals, 37.8 (37.0–38.8); width of nasals, 17.7 (15.9–19.6); length of molar series, 15.2 (14.5–15.8); diameter of external auditory meatus, 5.6 (5.3–5.9); breadth of brain-case (2 specimens), 25.0–25.7; length of palatal bridge, 5.9 (5.0–6.3). The average and extreme measurements of 4 adult females from Los Angeles and San Diego counties are as follows: Total length, 559.2 (545–580); tail vertebrae, 78.5 (65–93); hind foot, 117.7 (114–123); ear from crown (3 averaged), 152.3 (149–158); basilar length, 71.6 (68.7–73.4); zygomatic breadth, 41.9 (40.3–43.2); postorbital constriction, 12.8 (11.5–14.5); length of nasals, 38.5 (37.3–39.5); width of nasals, 18.0 (16.3–18.9); length of molar series, 15.7 (14.9–16.7); diameter of external auditory meatus, 5.7 (5.1–6.2); breadth of brain-case, 27.1 (25.9–27.6); length of palatal bridge, 5.8 (5.2–6.7).

Specimens examined.—A total of 23 from the following localities: Ventura County: Mt. Pinos, 5500 and 6500 feet altitude, 2; Montalvo, 2. Los Angeles County: Tujunga Wash, San Fernando, 1;

Arroyo Seco, Pasadena, 1. San Diego County: San Marcos (1 in collection Calif. Acad. Sci., 1 in collection Ralph Ellis), 7; Escondido (collection Ralph Ellis), 1; Vallecito, 1; San Felipe Valley, 3; Point Loma, 1; San Diego, 2; Tijuana River, 2.

***Lepus californicus deserticola* Mearns**

Plate 3, figure 4; Plate 4, figure 4

Lepus californicus, AUDUBON and BACHMAN (1854, p. 53), part.

Lepus texianus deserticola MEARNs (1896, p. 564), original description.

Lepus texensis deserticolus, ELLIOT (1901, p. 291).

Lepus texensis deserticola, ELLIOT (1905, p. 356).

Lepus californicus deserticola, NELSON (1909, p. 137).

Type.—Adult female; No. 8308 '6642, American Museum of Natural History; from the western edge of the Colorado Desert at the east base of the Coast Range, near the Mexican border, Imperial County, California; collected by Frank X. Holzner, May 7, 1894.

Geographic distribution.—The Mohave and Colorado deserts of southeastern California, north, east of the Sierra Nevada, as far as Woodfords, Alpine County (fig. 12). Zonal range, mainly Lower Sonoran, although locally extending up even into Hudsonian. Altitudinal range, from below sea level, as in Death Valley and around the Salton Sea, up to 12,500 feet.

Diagnosis.—Size, small; color, very pallid and pelage of fine texture; skull, small with rostrum relatively short and moderately narrow at base; auditory bullæ very large, both actually and relatively.

Adult fall pelage.—The following description is based upon a skin from 5 miles north of Needles, San Bernardino County, California. Subterminal band of guard hairs on back, top of head and anterior margins of flanks pale pinkish-cinnamon; apical band of black on these guard hairs relatively short, so that resulting mass effect is a pale ashy gray; anterior outer parts of ears more buffy than top of head, actually not differing noticeably from the color seen in *richardsoni* from upper Salinas Valley or southern San Joaquin Valley; black color of tips of ears not encroaching on inner parts of ears as seen in the race *californicus*; hairs on inner part of ears, except at tips and on grizzled areas near outer posterior margins, whitish; hairs along margins near tips of ears becoming pinkish-buff; terminal band of guard hairs on sides and under part of tail slightly paler than pale pinkish-cinnamon; anterior and lateral parts of fore

legs pale ochraceous-buff; tops of fore legs buffy; chest nearest pale ochraceous-buff, with terminal band of black absent on most hairs; guard hairs on lower margins of sides and on inner parts of hind legs pale ochraceous-buff; ventral pelage usually white from base to tip.

Skull (pl. 3, fig. 4; pl. 4, fig. 4).—Small and light in structure; rostrum relatively short and narrow at base; zygomata not widely expanded; jugals relatively broad; supraorbital processes small; palatal bridge proportionately long; auditory bullæ relatively large.

Lepus c. deserticola may be distinguished, cranially, from *L. c. bennettii* by the possession of a lighter skull with a smaller rostrum and larger auditory bullæ.

Remarks.—*Lepus c. deserticola* maintains its subspecific characters with a great degree of uniformity throughout its range on the deserts of southeastern California. A single specimen from the western slope of the Walker Pass, Kern County, while thought to be more nearly allied to this race, in respect to most of its subspecific characters, possesses a slightly yellowish tone of coloration not unlike that of *L. c. richardsoni*. Specimens from along the western margins of the Mohave and Colorado deserts at the east base of the coast ranges are as pallid as is usual for members of this race but show a slight tendency toward *L. c. bennettii* as regards shape of rostrum and size of auditory bullæ.

Measurements.—The average and extreme measurements of 4 adult males from Inyo, San Bernardino and Imperial counties are as follows: Total length, 561.5 (535–586); tail vertebrae, 94.5 (83–100); hind foot, 118.0 (110–124); ear from notch (1 specimen), 129; ear from crown (3 specimens), 167.7 (159–175); basilar length, (3 averaged), 72.3 (71.8–72.8); zygomatic breadth, 41.1 (40.0–41.7); postorbital constriction, 12.2 (10.9–13.3); length of nasals, 37.5 (36.9–38.2); width of nasals, 17.7 (17.0–18.5); length of molar series, 15.8 (15.5–16.3); diameter of external auditory meatus (3 averaged), 5.7 (5.4–5.9); breadth of brain-case (3 averaged), 27.5 (27.2–27.8); length of palatal bridge, 5.9 (5.3–6.6). The average and extreme measurements of 11 adult females from Inyo, San Bernardino and Imperial counties are as follows: Total length (8 averaged), 562.9 (540–585); tail vertebrae, 86.7 (70–96); hind foot, 124.3 (112–129); ear from notch (1 specimen), 134; ear from crown (9 averaged), 163.0 (150–175); basilar length, 71.7 (68.3–75.5); zygomatic breadth, 41.2 (39.1–42.3); postorbital constriction, 12.4 (11.0–13.8); length of

nasals, 36.2 (33.2–38.1); width of nasals, 17.6 (16.0–19.4); length of molar series, 15.9 (14.8–17.0); diameter of external auditory meatus, 5.8 (5.0–6.6); breadth of brain-case, 26.9 (25.5–28.9); length of palatal bridge, 6.3 (5.6–6.9).

Weights.—The average and extreme weights of 4 adult females from Inyo, San Bernardino and Imperial counties are 2165.5 (2047–2400) grams.

Specimens examined.—A total of 50 from the following localities: Alpine County: near Woodfords, 5600 feet altitude, 2. Mono County: Mono Mills, Mono Lake, 1; head of Silver Canyon, 10,000 feet altitude, White Mountains, 1; one-half mile south of McAfee Meadow, 12,500 feet altitude, 1. Inyo County: Farrington Ranch, Laws, 1; 5 miles southwest of Lone Pine (collection Ralph Ellis), 5; Keeler, 3604 feet altitude, 1; Wild Rose Canyon, 4000 feet altitude, Panamint Mountains, 1; Kelly's Well, Amargosa River, 1; Triangle Springs, —13 feet altitude, 1. Kern County: west slope of Walker Pass, 4600 feet altitude, 1; Kelso Valley, 1. San Bernardino County: Fairmont, Antelope Valley, 1; Victorville, 2; Doble, San Bernardino Mountains, 2; Cactus Flat, San Bernardino Mountains, 1; Sugar Loaf, San Bernardino Mountains, 2; Colorado River, 5 miles north of Needles, 480 feet altitude (collection Ralph Ellis), 1; Colorado River, 5 miles below Needles, 1; 20 miles south of Needles (collection Ralph Ellis), 1; Blythe Junction, 1. Riverside County: Whitewater, 1; Kenworthy, 2; Cabazon, 3; Mecca, 4; Palm Springs, 1; Cottonwood Spring (coll. Calif. Acad. Sci.), 1. Imperial County: 6 miles west of Imperial, 1; Imperial, 1; Coyote Wells, 2; Colorado River, 20 miles above Picacho, 1; Colorado River near Pilot Knob, 1.

***Lepus californicus wallawalla* Merriam**

Lepus callotis texianus, TRUE (1885, p. 601), part.

[*Lepus*] *texianus*, TROUSSART (1897, p. 661), part.

Lepus texensis, ELLIOT (1901, p. 290), part.

Lepus texianus wallawalla MERRIAM (1904b, p. 137), original description.

Lepus texensis wallawalla, ELLIOT (1905, p. 356).

Lepus texianus wallawalla, LYON and OSGOOD (1909, p. 31).

Lepus californicus wallawalla, NELSON (1909, p. 132).

Type.—Adult female, skin and skull; No. 23923/31328, United States National Museum, Biological Survey collection; from Touchet, Plains of the Columbia, Walla Walla County, Washington; collected by C. P. Streater, September 18, 1890; original No. 271.

Geographic distribution.—In general, the northeastern or Great Basin portion of California from central Siskiyou County east to the Nevada line and from the Oregon line south to eastern Plumas County (fig. 12). Zonal range, mainly Upper Sonoran, entering Transition locally. Altitudinal range, from about 3000 to 6000 feet.

Diagnosis.—Size, small; color almost as in *Lepus c. deserticola* and pelage of similar quality, but longer and more silky; skull very similar to that of *deserticola*, but with auditory bullae slightly smaller.

Adult full pelage.—Comparison of 7 adults of this race in fresh pelage from eastern Lassen County with a comparable series representing the race *deserticola* from the Mohave Desert, has failed to show any constant color differences between these two subspecies in California. The more northern race, *wallawalla*, possesses a pelage which is noticeably longer and more silky in appearance than seen in *deserticola*. This is probably of more ontogenetic than phylogenetic significance. There are, likewise, two average tendencies shown by *wallawalla* wherein it tends to differ from *deserticola*. First, a tendency toward a more nearly white subterminal band on the guard hairs of the top of the head and the back. Second, the guard hairs on the anterior and outer parts of the upper fore legs are between pinkish buff and light ochraceous-buff, whereas in *deserticola* they are usually pale ochraceous-buff.

Skull.—Small and light, with rostrum relatively short and slender basally; zygomata not broadly expanded; jugals relatively heavy; supraorbital processes small; palatal bridge proportionately long; auditory bullae large.

Specimens of *Lepus c. wallawalla* may be distinguished from those of *L. c. deserticola* by their somewhat smaller auditory bullae. From the race *californicus*, *wallawalla* may readily be distinguished by its smaller size, much smaller rostrum, less widely expanded zygomata, smaller supraorbital processes, relatively longer palatal bridge and larger auditory bullae.

Remarks.—*Lepus c. wallawalla*, as a race, is but slightly differentiated from *L. c. deserticola*. The most evident external feature characterizing the more northern subspecies is its longer, more silky pelage. This may or may not be of systematic importance. The color differences between the two races are slight at the most, being average in character. The principal cranial feature separating *wallawalla* from *deserticola* is the possession by members of the former race of

slightly smaller auditory bullæ. This again is only an average character with overlapping occurring throughout most of the ranges of both races.

No noticeable differences were observed between representatives of this race from Modoc and eastern Lassen counties, California, and a series of 4 near topotypes from Wallula, Walla Walla County, Washington.

Eight individuals examined from various localities in eastern and central Siskiyou County, as far west as the Shasta Valley, exhibit many characters intermediate between *wallawalla* and *californicus*. In color, specimens from this area may be described briefly as follows: subterminal band of guard hairs on top of head and back slightly darker than seen in *wallawalla* from eastern Lassen County; sides and under part of tail intermediate between *wallawalla* and *californicus*; lower margins of sides somewhat darker than seen in *wallawalla*; tops of hind feet covered with relatively short white hairs as in *californicus*. The general quality of the pelage over the entire body more nearly resembles that of the Sacramento Valley race than that of *wallawalla*, being relatively short and harsh. These specimens also show many intermediate cranial characters. The average basilar length of 5 adults is 72.8 mm. The rostrum is relatively long and broad at the base, although actually not as large as seen in *californicus*, whereas, the auditory bullæ are almost identical in size with those of the Sacramento Valley subspecies.

It appears possible, although so far as known, there is as yet no direct evidence to verify this opinion, that these two races may also intergrade with one another along the gap through which the Pitt River flows.

Measurements.—The average and extreme measurements of 8 adult males from Lassen and Modoc counties are as follows: Total length, 554.3 (526–585); tail vertebrae, 87.3 (66–105); hind foot, 128.4 (120–141); ear from crown (6 averaged), 149.6 (138–160); basilar length (7 averaged), 69.5 (66.4–71.9); zygomatic breadth, 40.5 (39.2–42.4); postorbital constriction, 11.8 (10.5–13.1); length of nasals, 35.8 (33.8–38.0); width of nasals, 17.2 (16.3–18.5); length of molar series (7 averaged), 15.7 (15.0–16.4); diameter of external auditory meatus, 5.5 (5.3–6.1); breadth of brain-case (7 averaged), 26.2 (25.1–27.1); length of palatal bridge, 6.2 (5.5–7.2). The average and extreme measurements of 7 adult females from Modoc and Lassen

counties are as follows: Total length, 538.7 (521–570); tail vertebræ, 83.8 (74–94); hind foot, 125.3 (117–135); basilar length, 68.8 (68.2–70.2); zygomatic breadth, 40.4 (39.0–41.2); postorbital constriction, 12.1 (11.4–12.6); length of nasals, 36.2 (35.0–37.3); width of nasals, 17.1 (16.4–18.4); length of molar series, 14.9 (14.4–15.3); diameter of external auditory meatus, 5.8 (5.1–6.5); breadth of brain-case, 25.9 (24.6–26.8); length of palatal bridge, 6.2 (5.8–6.4).

Weights.—The average and extreme weights of 4 adult males from Lassen County are as follows: 1901.2 (1077–2327) grams. The average and extreme weights of 5 adult females from Lassen County are as follows: 1968.0 (1090–2973) grams.

Specimens examined.—A total of 34 from the following localities: Siskiyou County: Hornbrook (coll. Calif. Acad. Sci.), 1; 13 miles south of Yreka, 1; 7 miles north of Gazelle, 3; Tecnor (coll. Calif. Acad. Sci.), 2; 1 mile southeast of Weed, 3600 feet altitude, 2. Modoc County: Dry Creek, Warner Mountains, 5; Alturas, 4600 feet altitude (6 in coll. Calif. Acad. Sci.), 7; 10 miles southwest of Alturas, 5000 and 5500 feet altitude, 2; Eagleville (coll. Calif. Acad. Sci.), 3. Lassen County: 4 miles southwest of McDonald Peak, 5300 feet altitude, 1; 7 miles north of Observation Peak, 5300 feet altitude, 1; 7 miles east of Ravendale, 5000 feet altitude, 6.

LIFE HISTORY

HABITAT

At first glance it might seem virtually impossible to define the habitat of so wide a ranging form as the black-tailed jack rabbit. In California, alone, members of this species may be found from below sea level, as in Death Valley, up to at least 12,500 feet altitude in the White Mountains, about 75 miles to the northwest; and from the humid, northwestern coastal plain of Humboldt County to the dry interior valleys and Mohave and Colorado deserts of southeastern California. Neither altitude, relative humidity nor rainfall appear to be critical distributional factors for this species as a whole, although they may serve to some extent for racial restriction. Temperature, at least in California, is nearly a negligible factor. Witness the extreme seasonal changes found in the northeastern part of the state, and the differences between the northwestern coast and the southeastern deserts in summer—all areas well inhabited by black-

tailed jack rabbits of one race or another. The type of soil, whether sandy, rocky or of other nature, does not seriously enter into the question, although extremely rocky country is probably an unfavorable condition. How then, may we characterize the ecologic niche occupied by populations of this species?

Certain environmental features do appear to present themselves constantly throughout the California range of this form. We may say in general that only open or semiopen country is occupied. The



Fig. 13 —A pasture land close to the San Joaquin River, Stanislaus County, California, which was frequented by numbers of jack rabbits during foraging hours. Photograph taken September 3, 1931.

extreme open type is chosen only where there is enough vegetation, even though exceedingly meager, to provide suitable shelter during the daily resting period. Dense areas of chaparral or forested regions, on the other hand, are entirely unsuitable for habitation. Jack rabbits, since they depend for protection upon their ability to run, require open or semiopen land where speed can be attained quickly and enemies can be detected at a considerable distance.

Certain characteristic features were observed with regard to the areas most preferred by jack rabbits in San Joaquin and Stanislaus counties. The greatest number of individuals was noted near loose stands of brush which bordered both the banks of the San Joaquin River and the nearby gullies and sloughs. Adjacent grain and stubble fields as well as pasture lands here provided suitable foraging areas (fig. 13). The low growth of vegetation present in these places, however, failed to supply adequate shelter for jack rabbits during

most of the midday hours of inactivity. This period of the day was spent largely in clumps of sandbar willow (*Salix sessilifolia*) where protection was afforded from the sun and from diurnal birds of prey. The dense wild rose and blackberry thickets lining the banks of the river were not used for this purpose to the same extent as was the willow, which grew farther away.

Along the east side of the Sacramento River in Butte County, in September, 1933, the writer found jack rabbits principally in the



Fig. 11 - Desert habitat of the black tailed jack rabbit, five miles northwest of Mohave, Kern County, California. Photograph taken October 3, 1931.

semiopen valley oak areas. Here they were found during the mid-day in forms, usually located where the grass was quite tall and ungrazed by domestic stock. Such situations usually occurred where fallen branches or shrubs deterred cattle and horses from cropping the grass close by. During foraging hours the rabbits were seen in clearings and in stubble and alfalfa fields. Where the oaks grew in dense groves, as happens locally in this region, no jack rabbits were found.

In eastern Lassen County, California, and in Nevada, the writer has seen this species mostly where desert bushes afforded a certain amount of shelter. In other words areas that were very barren or where the vegetation was of an extremely low-growing type were uninhabited. Jack rabbits were usually associated with shrubs which attained a height of two feet or more, such as rabbit brush (*Chrysothamnus* sp.), sagebrush (*Artemisia tridentata*), saltbrush (*Atriplex*

sp.) and *Tetradymia* sp. In southern Nevada and in southeastern California they have often been observed where the creosote bushes (*Larrea tridentata*) were dominant in the flora.

While driving between Redding, Tehama County, California, and Medford, Oregon, during the night and early morning of April 8, 1933, count was kept of the number of jack rabbits seen per mile by aid of the headlights of the machine and the light of a full moon. In the blue oak country, which is semiopen and continuous for some miles north of Redding by road, an average of two jack rabbits per mile was noted. Farther north, for the next five miles, where the vegetation becomes somewhat more brushy in character, rabbits were seen at the rate of about one per mile. Still farther north the vegetation is chiefly of an arborescent type, with a ground cover mostly of *Arctostaphylos viscida*. The count for the next ten miles showed but one jack rabbit, and from there north none was seen until the more or less open Shasta Valley was reached.

Grinnell, Dixon and Linsdale (1930, p. 546) record jack rabbits well up in the yellow pine regions of eastern Tehama County in summer. This is, however, as explained by the authors, only an "overflow movement participated in by but a relatively small part of the total population of the lower country . . ."

GENERAL HABITS AND BEHAVIOR

Forms and trails.—Jack rabbits regularly make use of forms, at least during the daytime between the morning and evening feeding periods. These forms, as they are generally called, are merely shallow excavations on the ground, situated as a rule partly beneath the protective shelter of shrubbery or an equivalent type of cover. Normally, they are located under the northern or northeastern portions of bushes so that the animals resting in them are out of direct sunlight during most of the daylight hours. The size of a form roughly corresponds to the length and breadth of its occupant's body. Usually the posterior portion of such a structure, that is the end closest to the base of a bush beneath which it is located, is excavated to a depth of several inches to accommodate the hind quarters of the reclining rabbit, whereas the earth is piled up anteriorly, somewhat above the general level of the ground, for the front of the body to rest upon. There is never any lining present.

In the Sacramento and San Joaquin valleys, the writer has fre-

quently found forms of black-tailed jack rabbits situated in tall grass close to stands of valley oaks, and beneath clumps of loose brush growing along the margins of creeks and rivers. Along the lupine-covered sand dunes near San Simeon, San Luis Obispo County, jack rabbit forms were commonly noted (Dixon, MS). One of these measured 14 by 16 inches, the deepest part being two inches below the surface of the sand.

On the Madeline Plains, in eastern Lassen County, the writer found jack rabbit forms situated most often partly beneath sagebrush or rabbit brush. Sometimes where the ground was baked hard and most of the shrubs possessed low foliage, almost contacting the ground, many small twigs which had been broken off from these overhanging plants were found in the forms (fig. 15). The measurements of one such form was 9 by 15 inches.

The length, breadth and greatest depth in inches of four forms measured by the writer near Millett P. O., Nye County, Nevada, are as follows: $10 \times 6 \times 1\frac{1}{2}$, $19 \times 11 \times 4$, $11 \times 9 \times 0$, $16 \times 8 \times 2$. All of these were located beneath the northern sides of desert shrubs.

As indicated by Vorhies and Taylor (1933, p. 485) members of this species make definite trails. In many localities when the soil is hard and unimpressible these paths are very inconspicuous. It appears probable that under such circumstances jack rabbits rely considerably upon their sense of smell in order to follow these definite routes. Grinnell, Dixon and Linsdale (1930, p. 547) mention the following observation relative to this phase of jack rabbit behavior: "On the morning of April 5, one came over a ridge and, hopping leisurely, left again after making a circuitous route. Within less than a minute, one, apparently another individual, came into sight and took almost the same route. This rabbit appeared to sniff at the ground as if following a scent." The writer has on several occasions witnessed a similar type of behavior.

In regions where the soil is soft or sandy and jack rabbits are abundant their trails are often quite conspicuous. In September, 1933, well-marked trails made by members of this species were observed in the sandy alluvium along the east side of the Sacramento River, in Butte County. During October, 1931, on the Madeline Plains in eastern Lassen County, tracks in fresh snow clearly indicated that many jack rabbits often follow the same trail. Observations made in a number of localities in southern Nevada have likewise shown that jack

rabbits, at least when inhabiting tracts of sandy desert, regularly follow definite trails.

Frequently rabbits which are scared away from a locality while



Fig. 15 - A typical jack rabbit form on the Madeline Plains eastern Lassen County, California. Photograph taken October 22, 1931.

feeding will be seen, after a period of patient waiting on the part of the observer, to return slowly with their noses close to the ground as though back trailing. In one instance, in Stanislaus County, a hare was seen to come loping through some willows. When first

noted it was traveling slowly, taking from fifteen to twenty hops at a time then pausing. Gradually the number of hops taken between pauses was decreased and the animal was seen to sniff the ground more often. Finally, it stopped along the margin of another clump of willows and reclined on its side. To the observer it was apparent that this individual had followed a definite trail, seemingly by scent, leading to this chosen spot.

Characteristic poses and movements.—When a jack rabbit is in a form during the daytime period of resting it normally has its body hunched up and its ears lowered over its back. Sometimes, especially toward the close of the morning period of feeding, rabbits will stay out in the open or hop to the margins of nearby clumps of brush and recline partly on their sides in the sunshine. This behavior was repeatedly observed in a number of localities. To cite one instance, in northern Stanislaus County, on September 3, 1931, at 7:10 A.M., the writer, after emerging from some brushland bordering the western side of the San Joaquin River, came into an open field where two jack rabbits were feeding. The animals apparently detected the presence of the observer because both ran a distance of about twenty yards from where they had first been noted and remained motionless for the next twenty minutes. Finally, one of the rabbits slowly hopped a short distance away to a shallow depression in the field, nibbled some grass and then reclined on its side and lowered its ears. The other one at the same time began to feed and then, after a few moments time had elapsed, hunched itself up into a resting posture also lowering its ears. Both individuals were well out in the open and faced toward the south.

When undisturbed and moving about slowly the tail is usually elevated over the back in the same manner as that of a cottontail. The ears frequently are partly lowered. Upon being frightened, however, the ears are immediately raised to a vertical position and the body is poised in readiness for flight. If the source of danger is detected and seemingly too close for comfort the disturbed individual will run off, with tail lowered and ears erect, usually to a distance of from thirty to one hundred yards where it will stop. Providing that danger is not imminent it will often remain motionless, sometimes for as long as twenty minutes, poised, however, in readiness for rapid departure. In the event that danger is impending this pause after the first short run is very brief or may be eliminated entirely.

As a general rule, just before a jack rabbit does pause, after running directly away from the source of disturbance, it veers off its course so that when it stops it is faced at a right angle to, rather than directly away from, the point of danger.

When running, jack rabbits, particularly those occurring in relatively open country, frequently bound high in the air. As has been suggested by Dice (1926, p. 13) this may be a means of more readily detecting the source of disturbance. Grinnell and Storer (1924, p. 222), referring to the manner in which jack rabbits elude their enemies, make the following statement: ". . . when thoroughly frightened, as when closely pursued by a hound, a coyote or an eagle, the animal stretches out to the utmost extent, the ears are laid down on the back, only the toes touch the ground, and the body is carried low. In this position the rabbit covers two to three yards at each bound."

Occasionally jack rabbits will resort to "freezing" or remaining perfectly motionless to avoid detection, especially when they are in forms during the middle of the day. In certain instances, however, this type of behavior is exhibited by rabbits in the open. For example, at dusk on October 23, 1931, on the south end of the Madeline Plains, in Lassen County, the writer came across a jack rabbit which was feeding at the edge of a clearing. Upon detecting the presence of the observer it ran a short distance, carrying a piece of sagebrush in its mouth. Then, as though it considered itself unnoticed, it stopped and crouched in the open. The ears were slowly lowered over the back and the front feet were drawn under the body. To all appearance in the fast waning light, it looked more like a rock than a rabbit. This was especially true after the observer had purposely taken his eyes off the animal for a few seconds while walking by within one hundred feet of it.

Swimming is generally resorted to by jack rabbits only when they are cornered or closely pursued, although Vorhies and Taylor (1933, p. 490) make record of one individual which "was observed to cross voluntarily a shallow stream, where two leaps in the water were necessary." Near Mendota, Fresno County, an immature jack rabbit was driven down a neck of land that was encircled on three sides by sloughs. When it came to the end of the dry land it hesitated and smelled the water, then plunged boldly in and swam rapidly fifty feet across the slough, which was between three and four feet deep.

Only the front feet were used in swimming. The rabbit seemed none the worse for its bath, shook itself on landing and then loped off as though nothing unusual had happened (Dixon, MS). E. L. Sumner, Jr. (1931, p. 279) states that on March 22, 1931, on the Los Banos Game Refuge, Merced County, a jack rabbit was seen to take to water to evade the observer who was two hundred yards distant. This animal swam with all but the head and shoulders beneath the water, the ears being lowered over the back.

Jack rabbits cleanse themselves by licking portions of their bodies, and also by licking their paws and rubbing them over parts not accessible to their tongues, such as the top of the head and the ears. These actions are performed by jack rabbits in much the same manner as by a house cat. Dust baths are probably also made use of, as indicated by Vorhies and Taylor (1933, p. 488). In the San Joaquin Valley mosquitoes were frequently seen to bother these animals to a considerable extent in the evening. At such times affected individuals were often seen to stop feeding and shake their heads violently from side to side, apparently in an effort to dislodge these pests from their long ears. Sometimes the hind feet were used to scratch the ears.

Reaction to each other and to other species.—Jack rabbits very often feed in groups rather than singly. In certain instances this may be due to the greater attraction, as regards food, that these chosen feeding grounds possess. At other times no differences in quality or quantity of food plants are discernable between areas where concentrated feeding occurs and surrounding regions, hence the only logical explanation of such action seems to be based on the assumption that jack rabbits tend at such times to be gregarious. Possibly this gregarious tendency is not altogether limited to the feeding period (cf. Vorhies and Taylor, 1933, p. 432).

When feeding in groups it seems probable that danger can be more readily detected than when individuals are feeding singly, due to the fact that a greater number of animals are on the alert watching for possible enemies. If jack rabbits are disturbed under such circumstances they do not all flee in the same direction but scatter as much as possible. Sometimes warnings of danger given by other animals appear to be heeded. The following observation regarding this feature of jack rabbit behavior is made by Grinnell, Dixon and Linsdale (1930, p. 548): "The seeming reliance with which these rabbits depend upon hearing rather than sight was demonstrated by

one observer near Cone's. A ground squirrel that was farther away from the observer than the rabbit gave an alarm note. The rabbit kept shifting and turning its ears, evidently, 'listening' in the direction of the squirrel, but appeared never to suspect the presence of a person although the observer stood in plain view."

On many occasions the writer has observed jack rabbits feeding within a few feet of both brush rabbits and cottontails. No animosity was ever apparent between these species at such times, although when individuals of the larger and smaller species came too close together the latter would hop away voluntarily.

Jack rabbits are reputed to indulge in considerable fighting, especially during the breeding season. Only twice during this study, however, were rabbits of this species observed behaving in a manner that might be interpreted as such. In southern San Joaquin County, on September 13, 1930, at 4:30 P.M., two individuals were seen sitting on their haunches facing each other in the shadow of a clump of willows. The distance between them was estimated to be about three feet. Every few minutes they were seen to leap into the air simultaneously and exchange positions. Sometimes one would jump completely over the other, at other times they would pass by each other at about the same level in mid-air. Upon landing each individual would turn about rapidly so as to again be facing his opponent. During the half hour that the writer watched these animals neither was seen to strike the other. It was uncertain as to whether they were actually fighting or indulging in a playful contest. At the same locality on October 19, 1930, at 6:00 A.M., a similar type of behavior was again observed on the part of two jack rabbits.

In another instance a single jack rabbit was seen to behave in a rather unusual manner which appeared belligerent in nature. In northern Stanislaus County, on September 3, 1931, while sitting motionless on a levee close to brushland bordering the western side of the San Joaquin River, a jack rabbit was seen to come running out of an extensive patch of loose brush at full speed. Its foot beats on the ground were quite audible when it was fifty yards away. It stopped when opposite the observer, whose presence was not suspected, and there remained motionless for a few seconds. Suddenly it turned about and raced back in the direction from whence it had come, traveling at top speed and at times lowering its ears over its back. It disappeared into the brush about one hundred yards away

and all was quiet for the next half minute. Again it came running back in the same manner to the point where it had stopped before. This time, instead of remaining motionless here, it pawed the ground with its right front foot before racing back to the brush. It returned a third time and repeated this performance. When it failed to make its appearance again, after a few minutes had elapsed, the writer went over to where it had disappeared in the brush and aroused a resting individual which was thought to be the same one which had previously been seen making the dashes.

FOOD HABITS

Feeding places.—Observations made on members of this species over a considerable period of time and in a number of different geographical localities have impressed upon the writer several facts concerning the sites selected for feeding by black-tailed jack rabbits. The presence of food is of course the most critical factor governing the suitability of feeding sites. Other features, however, besides the ready availability of suitable vegetation are essential. It very often happens that certain sites are chosen for this purpose that to all outward appearances are less favorable than other readily accessible situations close by. Jack rabbits seem to prefer feeding places which are not prominent; in other words situations that do not render them conspicuous from a great distance. Thus grassy hillsides or hill-tops or even moderate rises are invariably shunned. Situations are usually selected for feeding purposes which permit the visual detection of danger from a moderate distance. A few individuals do feed at times in small clearings in the brush, but by far the greater number forage out in the open, particularly in shallow depressions or hollows. During those seasons of the year, in certain regions, when brush forms an important item of food, feeding usually takes place along the margins of brushy tracts adjacent to open land.

Food

Times of feeding.—Feeding usually takes place during the early morning and evening hours, and during a portion of the night. Toward the latter part of September, 1933, in Butte County, the writer observed the greatest number of jack rabbits feeding in the morning around dawn. To cite one instance, on September 23, fourteen jack rabbits were seen between 4:45 and 5:00 A.M. along the edge of a

stubble field over a distance of approximately one-half a mile in length. By 6:30 A.M., not a single individual was to be seen. On the evening of September 24, at the same locality, the first hare was seen to come into the stubble field from an adjacent oak-forested area at 6:10 P.M. By 6:20 P.M. six individuals were in sight. Jack rabbits, however, had been seen feeding in small nearby clearings as early as 5:30 P.M.

During September, 1931, in Stanislaus County, jack rabbits were observed in numbers feeding out in the open in the early morning, from dawn until shortly after 7:00 A.M. In the evening many individuals could be seen by 6:00 P.M. During the latter part of October, 1931, in eastern Lassen County, many rabbits of this species could be seen feeding along the margins of the sagebrush by 4:30 P.M.

A considerable portion of the night appears to be devoted to feeding. Jack rabbits have frequently been noted out foraging up to three hours after dark. It is probable that the feeding period is of greater length during the period of full moon than on dark nights. While driving north through the upper end of the Sacramento Valley, on the night of April 7 and early morning of April 8, 1933, jack rabbits were seen commonly from sunset until 1:15 A.M. This was during the full of the moon.

Manner of feeding.—A feeding jack rabbit very much resembles a cottontail or brush rabbit in its behavior. When eating grass in the open the body is first hunched up. Gradually it is stretched out as the animal attempts to reach farther away. Ultimately, the hind legs are again brought up beneath the body with a hop and the original position is assumed. Consequently, rabbits, when undisturbed while feeding, move about very slowly. The animals are constantly alert for signs of danger during this period and frequently shift their large, erect ears around in an attempt to detect unusual sounds. The head is raised every twenty or thirty seconds to inspect the surroundings. During this pause chewing continues. The tail of a feeding animal is almost always elevated so that it is pressed back against the rump.

When feeding on brush, jack rabbits often sit on their hind quarters and reach for nearby twigs or leaves. Very often they will stand on their hind toes with the fore part of the body elevated in order to obtain food from the higher parts of the bushes. To cite an in-

stance, on October 23, 1931, near the south end of the Madeline Plains, Lassen County, a hare was seen to run to a point about seventy-five feet distant from the observer. Here, partially out of sight, it remained motionless for five minutes. At that time a second jack rabbit was seen, reclining on its side, about forty feet away. This individual arose and a third hare came loping through the sagebrush. Gradually all three began feeding on sage, slowly drawing closer together. Two of the individuals came very close to each other and rubbed noses. They hopped about slowly and sometimes leaned forward on the toes of their hind feet with the body elevated to a nearly vertical position, thus enabling them to reach the higher sage branches. The stems of these shrubs were cut off in lengths sometimes measuring as much as eight inches. Eating began from the cut off end. The leaves were let fall to the ground and no effort was made to retrieve them. When finally disturbed each made off in a different direction with a long stem of sage in its mouth.

The distance traveled daily by individual jack rabbits, in order to obtain suitable and sufficient food, varies considerably with the environment in which they live. In the Sacramento and San Joaquin valleys, which include the greater portions of the ranges of the races *californicus* and *richardsoni*, the distance between resting places and feeding sites frequently amounts to as much as one-half a mile or more. This is especially true over the floor of these valleys where jack rabbits are largely dependent upon trees and brush bordering watercourses for protection during the heat of the day. In San Joaquin and Stanislaus counties the writer frequently observed large numbers of rabbits in the morning and evening out in open fields, one-quarter of a mile away from loose brushland bordering the San Joaquin River.

Undoubtedly, the presence of certain particularly attractive foods, such as cultivated crops, may induce jack rabbits in some localities to traverse even greater distances. In Kern County, jack rabbits were found to travel between one-half and one mile from Caliente Wash to adjacent wheat fields to feed (Dixon, MS).

Observations made by the present writer in the fall of the year, in eastern Lassen County, indicate that in sagebrush-covered areas, at least during this season, the distance traversed by individual rabbits in order to obtain food is considerably less than in the Great Valley. The sage which provides shelter during the day is likewise

the main item of food. Hence travel is usually to nearby small clearings around the margins of which food is obtained.

Food plants.— Judging from observations made in the field it seems



Fig. 16.—Tracks of a jack rabbit in the snow leading to a clump of sagebrush where feeding took place, six miles east of Ravendale, Lassen County, California. Photograph taken October 26, 1931.

likely that jack rabbits, at least those inhabiting the valleys and foothills west and north of the desert regions in California, depend largely upon native and non-native grasses for food. Many other

different herbs as well as shrubs and cultivated plants supplement this diet of grass. Grinnell, Dixon and Linsdale (1930, p. 548) state that most of the individuals of this species seen feeding during the month of April, near Red Bluff, Tehama County, were eating alfalfa (*Erodium*).

In Butte County, southwest of Chico, a few hares were noted during September, 1933, feeding on green *Eragrostis hypnoides*, a grass which was common locally in small damp clearings not far from the Sacramento River. The majority of the jack rabbits observed feeding in this general region, however, were eating dry grass, barley stubble and green alfalfa. In San Joaquin and Stanislaus counties jack rabbits have frequently been seen eating grass during spring and fall months.

Referring to hares in the San Joaquin Valley, Dice (1926, p. 16) says as follows: "The grape growers complain of the damage done by these jack rabbits to the vineyards. They eat both the leaves and the young vines and also the grapes. One taken September 23, at Lemoore, had many grape seeds and skins in the stomach. In winter they are said to eat the bark of young orchard trees."

In parts of Tulare and Kern counties observations and the testimony of farmers indicated that considerable damage was done locally to barley, wheat and alfalfa crops (Dixon MS). H. C. Bryant (1916, p. 216) attributes much of the damage done to barley, melons, maize and Sudan grass near Ramona, San Diego County, to jack rabbits.

While studying rabbits in eastern Lassen County, in October, 1931, the writer found jack rabbits in this Great Basin section of California to be living almost entirely upon sagebrush (*Artemisia tridentata*). This was determined by direct observations on many living individuals as well as by stomach content analyses and by means of tracks in the snow (see fig. 16).

According to Howell (1924, p. 36) jack rabbits near Mammoth, Mono County, often obtain at least part of their winter food from the tops of "giant *Artemisia*" when snow covers most of the other vegetation.

On June 9, 1931, on the east slope of Irish Mountain, in southern Nevada, the writer observed an individual of this species eating desert juniper (*Juniperus californica* var. *utahensis*) and dry grass.

REPRODUCTION

Breeding season.—It appears probable that black-tailed jack rabbits breed in California, at least to some extent, during most months of the year. Pregnant females have been taken during January, February, April, June and December. Young of approximately two weeks or less in age have been noted most often during the month of May although specimens of this age have been taken in central and western Nevada during April and June. A nursing female was collected on October 30, at San Simeon, San Luis Obispo County. Similarly Dice (1926, p. 14) makes mention of two nursing females taken on September 17, at Angels Camp, Calaveras County.

It may be well here, however, to emphasize the fact that field records fail to indicate any sign of reproductive activity among jack rabbits in the Great Basin area of northeastern California and northern and central Nevada, during the winter months. This might be expected considering the severity of the winters and scarcity of food in this region, when compared with the interior valleys and coastal regions of California, where there are indications of reproduction during this period of the year.

An interesting contrast is seen between the peak of the breeding season of jack rabbits inhabiting California and of those occurring in southern Arizona. According to Vorhies and Taylor (1933) there are two peaks to the breeding season in southern Arizona, one in winter and one in summer, these being correlated with the two rainy seasons of that country, or, to be more exact, with the appearance of fresh vegetation. In California we likewise find this definite correlation but as there is only one annual period of precipitation we correspondingly find but one main peak to the breeding period. This occurs during the months of April and May.

Rate of reproduction.—While sufficient data are lacking to enable the writer to state definitely the number of litters born annually to each normal adult female jack rabbit there is much reason to believe that there are often as many as three, almost always one. Undoubtedly in April and May most of the females bear one litter, probably the largest with respect to number of young.

On April 11, 1922, near Huron, Fresno County, approximately one hundred jack rabbits were seen during the day (Dixon, MS). All of these were adults, with the exception of five individuals which

were from one quarter to three-quarters grown. Fifty-four of these were shot, thirty proving to be males and twenty-four females. An examination of the females showed all but one, an immature animal, to be pregnant. The mean number of embryos per litter was 5.3 with extremes of 3 and 7. The average length per embryo was found to be approximately 35 millimeters. On April 15, about ten miles south of this locality, sixteen more females were shot which, with two exceptions, an immature and a crippled animal, proved to be pregnant. The mean number of embryos in this instance was 5.1 with extremes of 3 and 8. These averaged approximately 60 millimeters in length. Here we witness an example wherein one hundred per cent of the normal adult females examined from within a limited area were found to be pregnant at the same time.

Embryo and field records indicate that a number of females bear young in December, January, during the early part of February, and in the autumn during the months of September and October. It may be that some of those animals reproducing in the autumn are young born late the previous year and breeding for the first time. The average number of young per litter for five pregnant females, taken in Monterey and Stanislaus counties during December, January and February, was 2.0 with the extremes 1 and 4. The number of embryo records for this period is small but does show, decidedly, that there are fewer individuals born per litter in winter than in spring.

It may be that in California the average number of young per litter varies from year to year in jack rabbits, depending upon certain environmental conditions which directly or indirectly effect physiological changes in the reproductive ability of these animals. This has been noted in the varying hare (*Lepus americanus*) by Elton (1925, p. 115) and is suggested by Heape (1931) as a cause of the periodic fluctuations in the populations of certain animals.

Nests and young.--Young black-tailed jack rabbits are fully haired and have their eyes open at the time of birth. In many instances the young are born in nests similar to those constructed by members of the genus *Sylvilagus* for their young. An adequate discussion of this subject together with observations on the behavior of the young of this species is given by Vorhies and Taylor (1933, pp. 501-510) and also to a lesser extent by Dickerson (1917).

A particular instance wherein a jack rabbit gave birth to young which were not placed in a nest is known. On September 21, 1934,

near Santa Cruz, California, an adult hare was seen in a plum orchard where the ground had been plowed. When the observer approached quite close it hopped slowly away revealing the presence of three young which, judging from their condition and the presence of a pool of blood, had been very recently born. The following day two of the young were in exactly the same location while the third was concealed four feet away. At no time while watched were they seen to move. No trace of these three young rabbits was found on September 23 (W. C. Russell, MS). This is probably not a normal occurrence. Perhaps the female gave premature birth to her young, or was disturbed just prior to the event.

Along the east base of the Toyabe Mountains, Nye County, Nevada, in May, 1930, only young jack rabbits were seen near the streams at about 6500 feet altitude. Farther east, one-half mile or more, where there were open flats and fields, at a somewhat lower elevation, most of the rabbits seen were adults (J. Linsdale, MS).

NATURAL ENEMIES

Mammals.—An adequate summary of information dealing with the relationship between coyotes and jack rabbits is given by Vorhies and Taylor (1933, p. 543). Bobcats (*Lynx rufus*) probably constitute another major enemy to this species. Jack rabbits are most likely to suffer from small carnivores during the early periods of life.

Birds.—Oberholser (1906, p. 24) mentions jack rabbits as one of the principal items of food for golden eagles (*Aquila chrysaetos*) near Hollister, California. He, likewise, cites an instance near Santa Clara, California, where a golden eagle was seen to pursue a large jack rabbit across a field, ultimately catching it. On September 29, 1931, while driving across Desert Valley, Lincoln County, Nevada, the present writer came across a pair of golden eagles which were eating a freshly killed jack rabbit. The body of the rabbit was almost entirely consumed, with the exception of the hind quarters and the skeleton which had been disarticulated. Even the braincase had been broken open and the contents eaten. In this instance most of the fur had been removed and was seen lying about.

An examination of the stomach contents of two American rough-legged hawks (*Buteo lagopus*), taken on January 28 and 29, 1935, respectively, in Honey Lake Valley, Lassen County, revealed the remains of black-tailed jack rabbits in both. One of the hawks weighed

two pounds eight ounces and contained six ounces of jack rabbit meat (Moffitt, MS).

On February 26, 1932, Mr. Ward C. Russell (MS) flushed a marsh hawk (*Circus hudsonius*) from the grass and sage on the east side of Buena Vista Lake, Kern County, California. The bird held an object in its talons which was dropped when a shot was fired. This appeared to be a very young jack rabbit which had the head eaten off.

Tyler (1913, p. 45) observed a duck hawk (*Falco peregrinus*) drop three times on a running jack rabbit which at the same time was being pursued by a coyote.

A. K. Fisher (1893, p. 134) mentions that portions of jack rabbits (*Lepus californicus*) were found in the burrows of barn owls (*Tyto alba*). These were probably young rabbits. Grinnell, Dixon and Linsdale (1930, p. 234) record finding part of a young jack rabbit at the nest of a horned owl (*Bubo virginianus*) along the banks of the Sacramento River, in Tehama County, California.

On June 21, 1919, near Chalk Peak, Monterey County, California, two California jays (*Aphelocoma californica*) were discovered eating a pair of young jack rabbits. The eyes and brains had been removed from the bodies of both animals (Hunt, MS).

Reptiles.—Gopher snakes and rattlesnakes are probably a menace to young jack rabbits. Klauber (1931, p. 73) records two young of this species found in a rattlesnake (*Crotalus confluentus oregonus*) at San Felipe, California, on March 24, 1931.

***Sylvilagus nuttallii* (Bachman)**

NUTTALL COTTONTAIL RABBIT

Plate 5

Specific diagnosis.—Size, moderately large for members of this genus, with total length of adults varying from 338 to 390 mm.; hind legs relatively long; hind feet broad and heavily haired; ears of medium length, rounded at tips and very noticeably haired on their inner or concave surface; vibrissæ never all black, some of the hairs being white or partly white; adults undergoing but one annual molt; tail large, grizzled above and pure white beneath; rostrum relatively long; supraorbital processes small, with their anterior projections abruptly pointed; postorbital extensions of supraorbitals slender, as in *Sylvilagus bachmani*; jugals proportionately slender; brain-case rather rounded; anterior palatine foramina usually not constricted posteriorly; palatal bridge of medium length and generally lacking a postero-median spine; auditory bullæ of medium size; molariform teeth relatively large; anterior surface of first upper molariform tooth possessing three re-entrant angles; posterior halves of second to fourth lower molariform teeth possessing lateral diameters which are rarely equal to more than one-half the lateral diameters of the anterior halves; ridge of enamel, separating the individual molariform teeth into anterior and posterior sections, strongly crenulated along median two-thirds.

***Sylvilagus nuttallii nuttallii* (Bachman)**

Plate 5, figures 1, 2

Lepus nuttallii BACHMAN (1837, p. 315), original description; ELLIOT (1901, p. 284).

Lepus artemesia BACHMAN (1839, p. 94).

Lepus artemesia, BAIRD (1857, p. 602).

[*Lepus sylvaticus*] var. *nuttalli*, ALLEN (1875, p. 131), part.

Lepus sylvaticus nuttalli, TRUE (1885, p. 601).

Lepus townsendi, TOWNSEND (1887, p. 181).

Sylvilagus (*Sylvilagus*) *nuttallii*, LYON (1904, p. 336).

Sylvilagus nuttalli [*nuttalli*], NELSON (1909, p. 201).

Sylvilagus nuttalli nuttallii, MILLER (1912, p. 364).

Type.—An immature specimen, approximately one-quarter grown; No. 382, Academy of Natural Sciences, Philadelphia; from eastern Oregon, near the mouth of the Malheur River (see Nelson, 1909, p. 203); collected August, 1834, by Thomas Nuttall.

Geographic distribution.—The Great Basin area of northeastern California, from central Siskiyou County east to Modoc County and south to Tiuckee, Nevada County (fig. 22). Zonal range, Upper So-

noran and Transition. Altitudinal range, so far as known, from 4500 to 6000 feet.

Diagnosis.—*Sylvilagus n. nuttallii* is distinguishable from *S. n. grangeri* of Mono and Inyo counties by the presence of a somewhat duller subterminal band and a longer apical band of black on the guard hairs of the dorsal parts.

Adult fall pelage.—The following description is based upon an average specimen chosen from a series of *nuttallii* from Modoc and Lassen counties: Subterminal band of guard hairs on back and top of head almost pinkish-buff, with long terminal band of black; basal part of hairs deep neutral gray; intermediate band below subterminal band nearly bone brown; rump dark gray, resulting from a white, subterminal band combined with a terminal band of black on the guard hairs; sides somewhat similar to rump but paler due to a shorter apical band of black and a slightly buffy tinge to the subterminal band; anterior, outer parts of ears paler than top of head, becoming black along upper margins and at tips; inner parts of ears rather heavily haired with whitish hairs; nape between pinkish-cinnamon and cinnamon anteriorly, becoming light pinkish-cinnamon posteriorly; tops of fore feet light pinkish-cinnamon; backs and sides of hind legs above heels cinnamon; tops of hind feet white with outer sides and fur at bases of toes varying from pinkish-cinnamon to light pinkish-cinnamon; underside of tail possessing conspicuously long white hairs; pelage on ventral parts of body deep neutral gray, basally, with terminal band of white present on all hairs except those of chest area which possess a terminal band that is nearly pinkish-buff.

Juvenile pelage.—Subterminal band of overhairs on upper parts between pale pinkish-buff and pinkish-buff; nape nearest cinnamon-buff; tops of fore legs, also backs and outer parts of hind legs above heels slightly brighter than pinkish-buff along terminal half of hairs; tops of fore feet slightly paler than tops of fore legs; tops of hind feet mostly white with some buffy color present as seen in adult pelage; rump patch not conspicuous; terminal portion of ventral pelage white, with exception of chest area which is pinkish-buff.

Postjuvenile pelage.—Similar to that of adults, but paler in mass effect due to shorter pelage and shorter apical area of black on guard hairs; ears not so heavily haired inside; color on fore and hind legs not so bright as seen in adults; number of guard hairs relatively fewer on these parts; rump patch not pronounced.

Skull (pl. 5, figs. 1, 2).—Smaller in size than that of *Sylvilagus n. pinetis* with auditory bullæ averaging larger than those possessed by the latter race.

Remarks.—No noticeable geographic variation was apparent throughout the range of this subspecies in northeastern California. It might be said for the species as a whole that despite its relatively large range it exhibits very little geographic variability.

Measurements.—The average and extreme measurements for 12 adult males from Modoc and Lassen counties are as follows: Total length, (11 averaged), 352.4 (338–371); tail vertebræ, 43.7 (30–54); hind foot, 94.6 (87–110); basilar length (11 averaged), 49.6 (48.2–50.7); zygomatic breadth, 32.8 (30.7–33.5); postorbital constriction (11 averaged), 11.1 (10.3–11.8); length of nasals, 28.9 (24.7–29.7); width of nasals, 13.6 (12.1–15.0); length of molar series, 12.4 (12.0–12.9); diameter of external auditory meatus, 4.9 (4.7–5.4); breadth of brain-case, 22.0 (20.9–22.6); length of palatal bridge, 5.6 (5.1–5.9). The average and extreme measurements of 7 adult females from Modoc and Lassen counties are as follows: Total length, 372.0 (345–390); tail vertebræ, 49.6 (36–54); hind foot, 94.3 (90–101); basilar length (6 averaged), 49.5 (48.1–51.7); zygomatic breadth, 33.0 (32.1–33.6); postorbital constriction, 11.4 (10.8–11.8); length of nasals, 28.7 (27.7–30.9); width of nasals, 13.6 (12.8–14.5); length of molar series, 12.5 (12.2–12.6); diameter of external auditory meatus, 4.8 (4.1–5.4); breadth of brain-case (6 averaged), 22.3 (21.8–22.9); length of palatal bridge, 5.6 (5.3–6.0).

Weights.—The average and extreme weights of 4 adult males from Modoc and Lassen counties are 719.9 (628.5–830) grams. The average and extreme weights of 4 adult females from the same area are 790.3 (690–871) grams.

Specimens examined.—A total of 59 from the following localities: Siskiyou County: Tecnor (coll. Calif. Acad. Sci.), 3; Yreka (coll. Calif. Acad. Sci.), 1; Bray (coll. Calif. Acad. Sci.), 1; 4 miles west of Weed, 1. Modoc County: Steele Meadows, 4700 feet altitude, 1; Sugar Hill 4800–5000 feet altitude, 10; Parker Creek, 5300 feet altitude, Warner Mountains, 1; Dry Creek, 4750–4800 feet altitude, Warner Mountains, 7; South Fork of Pitt River, Warner Mountains (coll. Calif. Acad. Sci.), 4; Eagleville (coll. Calif. Acad. Sci.), 5; 13 miles northeast of Eagleville (coll. Calif. Acad. Sci.), 1; Happy Camp (coll. Calif. Acad. Sci.), 1; Jess Valley (coll. Calif. Acad. Sci.), 2; Cedarville

(coll. Calif. Acad. Sci.), 1; Shields Creek, 5000 feet altitude, 1; 5 miles southwest of Alturas, 4500 feet altitude, 1; 10 miles southeast of Alturas, 5000 feet altitude, 1. Lassen County: 4 miles southwest of McDonald Peak, 5300 feet altitude, 4; 1 mile west of Red Rock P. O., 1; 7 miles east of Ravendale, 5000 feet altitude, 3; Pine Creek, Eagle Lake, 1; 5 miles north of Fredonyer Peak, 4; Grasshopper Valley, 5400 feet altitude, 1; Petes Valley, 4500 feet altitude, 1. Plumas County: Beckwith, 5000 feet altitude, 1. Nevada County: Truckee, 1.

***Sylvilagus nuttallii grangeri* (Allen)**

Plate 5, figures 3, 4

[*Lepus sylvaticus*] var. *nuttalli*, ALLEN (1875, p. 434), part.

Lepus sylvaticus grangeri ALLEN (1895, p. 264), original description.

Lepus [alticinctus]. perplicatus ELLIOT (1903*b*, p. 225).

Sylvilagus (Sylvilagus) grangeri, LYON (1904, p. 336).

Sylvilagus nuttalli grangeri, NELSON (1909, p. 204).

Sylvilagus nuttalli grangeri, MILLER (1912, p. 364).

Type.—Adult male; No. 9094 '7402, American Museum of Natural History; from Hill City, Pennington (Custer?) County, South Dakota; collected August 11, 1894, by W. W. Granger.

Geographic distribution.—The mountainous and plateau areas of California, east of the crest of the Sierra Nevada, from Alpine County south to the Panamint Mountains of Inyo County (fig. 22). Zonal range, Upper Sonoran and Transition. Altitudinal range, from 6200 to 10,500 feet.

Diagnosis.—Representatives of this race, from within the area circumscribed above for *grangeri* in California, are distinguished most easily from true *nuttalli* by their more pinkish tone of coloration.

Adult fall pelage.—The following description is based upon a series from the Panamint Mountains, Inyo County, California. Color, similar in general to *nuttalli* but with subterminal band of guard hairs on dorsal parts of body more pinkish and of considerably greater extent; terminal band of black shorter, resulting in a lighter body color; basal parts of hairs neutral gray; band below subterminal band nearest bister; rump paler than in *nuttalli*, due to reduced apical band of black with corresponding increase in breadth of white subterminal band; sides relatively paler than in *nuttalli*; black area on distal margins of ears somewhat reduced in extent; tops of fore legs and lateral and posterior parts of hind legs above

heels slightly paler than in the more northern race; terminal band of white longer on hairs of ventral parts of body.

Skull (pl. 5, figs. 3, 4).—Similar, in California-taken specimens, to *Sylvilagus n. nuttalli* except for slightly smaller average size. See below under *Remarks*.

Remarks.—For the purpose of gaining a clearer concept of the sub-specific relationships of *Sylvilagus nuttalli* in eastern California to the species throughout the remainder of its range, use was made of all available material from the southern half of Nevada in the collection of the Museum of Vertebrate Zoölogy. Briefly, I find that the specimens from southern Nevada and adjacent parts of California do not differ appreciably, as regards skulls, from *nuttalli* of northeastern California, save possibly in a slightly smaller average size. These representatives of the race *nuttalli* from Modoc and Lassen counties, California, are a little larger than typical specimens according to Nelson (1909, p. 203). However, neither these nor the southern Nevada and California specimens attain the size indicated by Nelson in his table of measurements (*loc. cit.*, p. 201) for *S. n. grangeri* from Montana. Likewise, Nelson (*loc. cit.*, p. 206) comments upon the smaller size of *grangeri* in southwestern Nevada and adjacent parts of California, stating that "these differences are within those ordinarily seen between extremes of the same form." An inadequate number of adult skulls from the Panamint Mountains were actually smaller than any examined from other localities within the range of the species.

A color comparison of a series of skins in fresh fall pelage from the Toiyabe Mountain region of central Nevada with a similar series representing *nuttalli* from the Modoc Great Basin area of California showed the former to be very noticeably paler. The central Nevada skins generally lack much of the pinkish color of the Panamint Mountain specimens. In view of these indications of a slight geographic variation in southeastern California, further material from this area may warrant the use of the name *perplicatus* proposed by Elliot (1903b, p. 255) to indicate this tendency toward more pinkish coloration and smaller size than is possessed by *grangeri*.

Specimens from Alpine and Mono counties are best placed with the race *grangeri* of southeastern California, as here understood, because of their paler and more pinkish color.

Measurements.—The average and extreme measurements of 6

adult males from southwestern Nevada are as follows: Total length, 344.0 (338–352); tail vertebræ (5 averaged), 47.6 (35–57); hind foot, 93.2 (90–98); ear from notch (2 specimens), 70–85; basilar length, 50.0 (48.3–51.2); zygomatic breadth (5 averaged), 32.8 (32.4–33.3); postorbital constriction, 11.0 (10.6–11.7); length of nasals, 28.3 (25.2–30.0); width of nasals, 14.0 (13.0–15.6); length of molar series, 12.5 (12.3–12.8); diameter of external auditory meatus, 4.9 (4.5–5.2); breadth of brain-case, 21.8 (21.1–22.4); length of palatal bridge, 5.5 (5.3–5.8). The average and extreme measurements of 5 adult females from southwestern Nevada are as follows: Total length, 351.0 (341–363); tail vertebræ, 47.2 (30–59); hind foot, 93.3 (91–95); ear from notch (2 specimens), 65–68; basilar length, 49.7 (48.6–50.5); zygomatic breadth, 32.0 (30.9–33.0); postorbital constriction, 10.9 (10.7–11.0); length of nasals, 28.3 (27.8–30.1); width of nasals, 13.2 (12.5–14.0); length of molar series, 12.5 (12.1–12.8); diameter of external auditory meatus, 4.8 (4.5–5.3); breadth of brain-case, 22.0 (21.5–22.6); length of palatal bridge, 5.3 (4.5–5.6).

Weights.—The weight of one adult male from southwestern Nevada is 677.5 grams. The average and extreme weights of 3 adult females from southwestern Nevada are 928.2 (867.7–1032.3) grams.

Specimens examined.—A total of 19 from the following localities: Alpine County: near Woodfords, 5500 feet altitude, 2. Mono County: Williams Butte, 1. Inyo County: near Big Prospector Meadows, 10,300 to 10,500 feet altitude, White Mountains, 2; Silver Canyon, 4500 to 7000 feet altitude, 2; two and one-half miles southeast of head of Black Canyon, 8000 feet altitude, White Mountains, 2; near Jackass Spring, 6200–6500 feet altitude, Panamint Mountains, 7; one mile south of Lee Pump, 6100 feet altitude, Panamint Mountains, 2; Johnson Canyon, 6500 feet altitude, Panamint Mountains, 1.

LIFE HISTORY

HABITAT

The Nuttall cottontail is typically an inhabitant of sagebrush, occurring in California only in the extreme eastern and northeastern plateau regions. Normally, members of this species are found to occupy rocky, sage-covered hills and canyons in preference to plains (fig. 17). Locally, it is to be found living in willow or dense brush associations, often near springs or watercourses. The decided preference of the species for the higher, rocky, sage-grown regions is



Fig. 17.—Showing the rocky crest of a sage covered ridge, inhabited by Nuttall cottontails, six miles east of Ravendale, Lassen County, California. Photograph taken October 24, 1931.



Fig. 18.—Typical habitat of the Nuttall cottontail in the southern portion of the Belled Range, Nye County, Nevada. Note the sage-grown valley surrounded by stands of juniper and piñon pine. Photograph taken September 28, 1931.

strikingly seen in south-central Nevada (fig. 18) where the desert valleys are inhabited by Audubon cottontails and the adjacent mountain ranges by Nuttall cottontails.

In October, 1931, on the south edge of the Madeline Plains in eastern Lassen County, California, the writer found individuals of this species inhabiting the tops and sides of small ridges, where sagebrush (*Artemisia tridentata*), mountain mahogany (*Cercocarpus ledifolius*) and western juniper (*Juniperus occidentalis*) were the dominant species of plants. Others were observed in small washes and ravines where rabbit brush (*Chrysothamnus nauseosus*) was as abundant as sagebrush. Cottontails were frequently associated with large outcroppings of rock such as are often inhabited by bushy-tailed woodrats (*Neotoma cinerea*) in this region. No cottontails were noted on the nearby plains. This apparently was due to the lack of suitable shelter, either in the form of dense clumps of brush of a sufficiently large size, or of burrows or rock crevices on these flats. This same choice of habitat has been noted by Dice (1926, p. 17) among members of this species in eastern Washington.

Opportunity was had for studying this species in Big Smoky Valley, Nye County, Nevada, during parts of May and June, 1932. Five miles southwest of Millett Post Office, individuals were seen almost daily near springs. Their usual retreats, when disturbed from grassy clearings during feeding hours, were dense clumps of wild rose (*Rosa* sp.), golden currant (*Ribes aureum*) and buffalo berry (*Shepherdia argentea*). None were seen on the upland desert several miles to the west, where the perennial vegetation was composed of well-spaced, low-growing shrubs. Still farther to the westward, in the Toiyabe Mountains, Nuttall cottontails were again encountered in rocky canyons and about streamside growth.

GENERAL HABITS AND BEHAVIOR

Nuttall cottontails, like many other members of the genus *Sylvilagus*, apparently make use of forms and burrows depending upon the nature of the environment in which they are living. Rabbits inhabiting dense tracts of sagebrush or riparian growth probably spend most of their resting hours above ground under the protection of the dense cover afforded by this vegetation. On the other hand, rabbits occurring in areas where the brush is loose frequently resort to burrows or crevices in rocks for protection during resting

hours. In eastern Lassen County a burrow which was known by observation to be used by an individual of this species was excavated on October 22, 1931. It was located beneath a large clump of sagebrush in the bottom of a small ravine. There were two entrances with tunnels from each extending at right angles to the other for a distance of three feet before they joined. At the junction of these two tunnels there was a small pocket containing some dried green grass that had evidently been cut the previous spring. The greatest depth of this burrow system was close to the pocket where the distance between the surface of the ground above and the top of the tunnel was twenty inches. Feces of adult and young rabbits, found both in the tunnels and in the pocket, indicated a possibility that young were born and reared there. It is of interest to note that the entrance to a burrow belonging to a Columbian kangaroo rat (*Dipodomys ordii columbianus*) was located just inside one of the tunnels of the rabbit burrow. It is not yet known to the writer whether cottontails of this species dig their own burrows, or whether they are originally excavated by other species of mammals.

Nuttall cottontails appear to be somewhat more solitary in habits than do certain other members of the genus *Sylvilagus*. This may be attributed largely to the environment in which they live. As a general rule conditions are rather uniform in sagebrush country. Grassy clearings which, when present, prove very attractive to rabbits living in the vicinity are of rare occurrence. Where such patches of green grass do occur, however, as occasionally seen adjacent to streamside growth or about springs, members of this species appear to concentrate at these places in the same manner that Audubon cottontails or brush rabbits are more frequently seen to do throughout their respective ranges.

Upon being disturbed, especially when feeding in tracts of sagebrush, members of this species usually make a short run, anywhere from five to fifteen yards, away from the point of danger. Following this the aroused individual will pause, either facing directly away from or at an angle to the source of disturbance. The ears are held erect and motionless and generally the animal is fairly well screened from observation by the intervening brush. If any further noise or movement is detected by the frightened rabbit it will immediately hop away, following a semi-circular route so as to fool the pursuer and draw attention away from the actual direction of retreat.

FOOD HABITS

Nuttall cottontails feed either within the shelter of brush or, if grassy clearings are present, a few yards out in the open away from cover. These latter situations, sometimes found along creeks or near springs, seem to be preferred by members of this species. On October 27, 1931, cottontails were noted in Secret Valley, eastern Lassen County. Several individuals were observed feeding in a small, grassy clearing surrounded on all sides by sagebrush and within a short distance of the northeastern slope of the valley. Grinnell, Dixon and Linsdale (1930, p. 550) state that on June 16, 1929, several cottontails were seen in thickets bordering the stream and on the rocky canyon walls in this same valley.

Like other nearly related members of this genus these cottontails feed mostly during the early morning and evening hours. In the latter part of October, 1931, near the south end of the Madeline Plains, Lassen County, cottontails were seen out feeding from dawn until 9:30 A.M. and again in the afternoon as early as 2:30 o'clock. The greatest number of individuals, however, was seen between dawn and sunrise and from shortly before sunset until dark. In the latter part of May, 1931, at the southwest base of Groom Baldy, Lincoln County, Nevada, the largest number of cottontails observed in the evening along the grass-grown margin of a creek was between 5:15 o'clock and dark.

Heavy rain and wind, apparently have an unfavorable effect upon open ground feeding activity. Very few individuals have been observed out under such inclement weather conditions. On October 26, 1931, in eastern Lassen County, after a night's snowfall, tracks of these rabbits were found in abundance shortly after dawn on the surface of the fresh snow. Although the temperature at this time was only 14° F., the cold apparently had not interfered with their pre-dawn activity.

The principal food of this species in eastern Lassen County during the fall months, probably also during most of the year, was found to be sagebrush. Western juniper (*Juniperus occidentalis*) is eaten to some extent. After the first snowfall few other plants aside from the two above-mentioned species are available in this region. In the spring and summer, grass, where obtainable, is selected in preference to other types of vegetation.

REPRODUCTION

The breeding season of Nuttall cottontails is limited to the spring and early summer. Pregnant females have been taken during the months of April, May, June and July in northeastern California and in Nevada. Young, one-fourth to one-third grown, have been collected between May and July. It is perhaps significant that most of the pregnant females have been taken during the early part of June, whereas, the majority of young less than half-grown have been captured during the latter part of June.

The number of litters of young born annually to adult females is not definitely known, although it appears highly probable that this number normally does not exceed two at most. The mean number of embryos for 8 pregnant females is 6.1 with extremes of 4 and 8. Considering that all late fall- and winter-taken specimens are in adult pelage it would seem that mature size is attained in less than a year.

A nest of this species containing four young was found on May 30, 1931, at an elevation of 9000 feet on the north side of Gloom Baldy, Lincoln County, Nevada (Hall, MS). It was situated at the southern base of a piñon pine on a ground surface composed of small rocks, pine needles and twigs. The nest consisted of a cup-like cavity lined with rabbit fur and dry grass. The top was covered over with fur, grass and a stick three-eighths of an inch in diameter, all of which the observer believed had been placed there by the female. A faint path led away from the structure, and a blind tunnel led out from the nest and around the uphill side of the tree trunk into a mass of piñon needles which had accumulated in places to a depth of 16 inches. This blind tunnel appeared too small to have been made by the female, and was thought to have accidentally resulted from movement on the part of the young. One of the latter sought refuge in this tunnel when an attempt was made to reach into the nest. Each of the four young screamed when taken in hand and refused, after being replaced, to stay in the nest. This, the observer commented in his notes, recalled to mind the behavior of young birds just prior to the time at which the nest is left.

One of the above specimens was brought back to the present writer at camp and was kept until June 3, at which time it was dispatched. Its weight shortly after being captured was 74 grams and the body

measurements in millimeters were as follows: total length, 145; tail length, 18; hind foot, 42; ear from notch, 35. Since it was fully haired and had the eyes open, it was estimated to be between one and two weeks old. All efforts to induce this young rabbit to eat grass failed.

Three young cottontails weighing 40.1, 41.9 and 46.9 grams, respectively, were captured on May 7 and 8, 1931, in or about an old cabin in the Belted Range, Nye County, Nevada (Russell, MS). These three individuals were considerably smaller than the young noted on Groom Baldy, but were seemingly able to move about at this age. Perhaps the presence of people about this deserted house had frightened the mother away, causing the young to leave the nest earlier than normal.

For many years it has generally been accepted as a fact that the young of the genus *Sylvilagus* are naked at birth. Recent observations upon certain species of this genus (*cf.* Dice, 1929, p. 227; 1933, p. 162; Svihla, 1929, p. 316) have shown that young of the eastern cottontail (*Sylvilagus floridanus*) and the marsh rabbit (*Sylvilagus aquaticus*) are born with a short, silky pelage covering most of the body. No information was obtained regarding the appearance of Nuttall cottontails at this age, but it appears probable that at time of birth young of this species have their eyes closed, and possess a short type of pelage similar to that of eastern cottontails of a comparable age.

NATURAL ENEMIES

Undoubtedly bobcats (*Lynx rufus*) and coyotes (*Canis latrans*) are the most important mammal enemies of Nuttall cottontails. Borell and Ellis (1931, p. 11) by stomach content analyses found the following species of birds to prey upon cottontails in the Ruby Mountain region of Nevada: horned owl (*Bubo virginianus*), long-eared owl (*Asio wilsonianus*), red-tailed hawk (*Buteo borealis*), Swainson hawk (*Buteo swainsoni*) and marsh hawk (*Circus hudsonius*).

Grinnell, Dixon and Linsdale (1930, p. 153) mention an instance where a half-grown cottontail was seen very close to a rattlesnake (*Crotalus confluentus oregonus*) in northeastern Lassen County, California. When approached the rabbit would not hurry away but gave the impression that it had either been terrified by the snake, or possibly bitten.

***Sylvilagus audubonii* (Baird)**

AUDUBON COTTONTAIL RABBIT

Plates 6, 7

Specific diagnosis.—Size, large with total length of adults varying from 340 to 434 mm.; hind legs relatively long; hind feet proportionately slender and lacking conspicuously long, dense pelage such as is possessed by *Sylvilagus nuttallii*; ears long, rather pointed and somewhat sparsely haired on their inner, concave surface; vibrissæ entirely black as a rule; adults undergoing but one annual molt; tail large, grizzled above and pure white beneath; rostrum relatively long; supraorbital processes large with the tips of the anterior projections rather blunt; postorbital extensions of supraorbital processes broad; jugals proportionately broad; brain-case comparatively broad; anterior palatine foramina frequently constricted posteriorly; palatal bridge of medium length and usually possessing a postero-median spine; auditory bullæ varying from medium size to large; molariform teeth relatively large; anterior surface of first upper molariform tooth possessing three re-entrant angles; posterior halves of the second to the fourth lower molariform teeth possessing lateral diameters which are equal to about four-fifths the lateral diameters of the anterior halves; ridge of enamel, separating the individual molariform teeth into anterior and posterior sections, strongly crenulated along median two-thirds.

***Sylvilagus audubonii audubonii* (Baird)**

Plate 6, figure 1; Plate 7, figure 1

Lepus audubonii BAIRD (1857, p. 608), original description.

Lepus sylvaticus var. *auduboni*, ALLEN (1875, p. 434), part.

Lepus sylvaticus auduboni, TRUE (1885, p. 601), part.

Lepus floridanus auduboni, MILLER (1899, p. 389).

Lepus floridanus audubonii, MILLER and REHN (1901, p. 185), [combination said to be untenable].

Sylvilagus (Sylvilagus) floridanus audubonii, LYON (1904, p. 336).

Sylvilagus auduboni, TROUESSART (1904, p. 538), part.

Lepus auduboni, ELLIOT (1905, p. 345), part.

Lepus audubonii, LYON and OSGOOD (1909, p. 288), [type designated and type locality restricted].

Sylvilagus auduboni [*auduboni*], NELSON (1909, p. 214).

Sylvilagus audubonii audubonii, MILLER (1912, p. 365).

Type.—Skin and skull (both now lost); No. 1163/2045, United States National Museum; from San Francisco, California; received from Lieut. R. S. Williamson and collected by Dr. J. S. Newberry (*vide* Lyon and Osgood, 1909, p. 288).

Geographic distribution.—From Tehama County at the northern

end of the Sacramento Valley, south to northeastern Merced County in the northern San Joaquin Valley, also including the lower Salinas Valley in northern Monterey County. Mainly inland in distribution, reaching the coast only in the vicinity of San Francisco Bay and

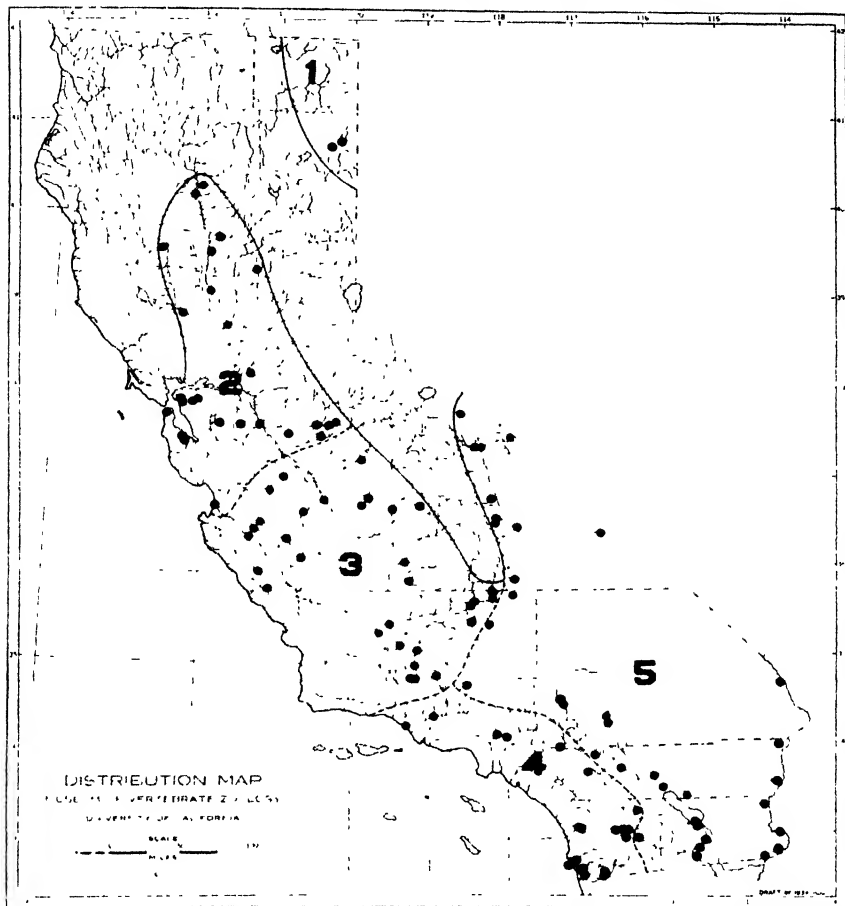


Fig. 19—Range of the Audubon cottontail (*Sylvilagus auduboni*) and pigmy rabbit (*Sylvilagus idahoensis*) in California. 1, *Sylvilagus idahoensis*; 2, *Sylvilagus a. auduboni*; 3, *S. a. vallicola*; 4, *S. a. sanctidiegi*; 5, *S. a. arizonæ*.

Monterey Bay (fig. 19). Zonal range, Lower and Upper Sonoran. Altitudinal range, from sea level to approximately 1500 feet.

Diagnosis.—Size, large with ears relatively short; color, dark, equaled only by *sanctidiegi*; pelage rather harsh in quality; skull, large with rostrum proportionately short and broad at base; auditory bullæ quite small.

Adult fall pelage.—The following description is based upon an average specimen from Tehama County, California, taken during December. Back, top of head and anterior margins of flanks nearest light ochraceous-buff on subterminal band of overhairs, with basal portion deep neutral gray; apical band of black on these hairs relatively long and conspicuous; rump paler than back, with terminal band of black somewhat reduced and subterminal band lighter; top of tail similar to back with respect to color of terminal and subterminal bands of guard hairs; underside of tail possessing conspicuously long hairs which are white from base to tip; anterior outer portions of ears similar in color to top of head, but more finely grizzled due to shortness of pelage; extreme tips of ears black; anterior rims of ears margined along proximal two-thirds with medium-long, buffy hairs, some of which possess a small amount of black pigment at their tips; inner posterior portions of ears possessing a scanty covering of whitish hairs, which, near tips of ears becomes somewhat buffy; outer posterior parts of ears sparsely covered with whitish hairs which merge into black near tips of ears; nape between cinnamon and ochraceous-tawny; sides of nose and circumorbital regions paler than top of head, with terminal band of black on guard hairs very much reduced or entirely absent; vibrissae entirely black; sides of body paler than back with terminal band of black much reduced; tops of fore legs between pinkish-cinnamon and cinnamon, becoming paler and blotched with white on tops of fore feet; hind legs above heels between light ochraceous-buff and pinkish-cinnamon on subterminal band, with a very narrow terminal band of black on most hairs; tops of hind feet white with sides and hairs between toes somewhat buffy; chest similar to sides with terminal band of black either absent or so reduced as to be barely visible; hairs on ventral parts of body always white distally and usually white to base in mid-ventral region.

Juvenile pelage.—Subterminal band of guard hairs on dorsal parts similar in color to that of adults, but mass effect of dorsal pelage appearing slightly paler (see p. 24); nape between light ochraceous-buff and cinnamon-buff in all four races studied; ears possessing conspicuous black tips, as seen in adult pelage; tops of fore legs, fore feet and hind legs above heels somewhat paler than noted in adults; tops of hind feet possessing hairs which are buffy at tips.

Considerable change is evident in the appearance of this pelage

from birth until it is replaced by the postjuvenile. At birth (or at least shortly thereafter) the hair is short and very closely pressed to the surface of the body, resulting in a smooth, silky appearance. Some time before the young are ready to leave the nest the pelage becomes quite the reverse, assuming a rather woolly texture. As the young increase in size this becomes less apparent due to the continued increase in body size and the failure of the hairs to increase in length after the first weeks.

Postjuvenile pelage.—Similar to adult pelage as regards color of hair bands, but paler in mass effect due to shorter, finer hairs and shorter terminal and subterminal bands on guard hairs.

Skull (pl. 6, fig. 1; pl. 7, fig. 1).—Size, large; rostrum relatively short, tapering from a broad base; brain-case rather broad; zygomata widely expanded; jugals broad; anterior palatine foramina short and broad posteriorly; palatal bridge of medium length; auditory bullæ relatively and actually quite small; molar series long.

The most outstanding cranial features distinguishing *auduboni* from *vallicola* are the presence in the former race of a relatively shorter and basally broader rostrum, more widely expanded zygomata, heavier jugals, comparatively longer molar series and slightly smaller auditory bullæ.

Remarks.—Specimens from Tehama and Butte counties exhibit the brightest type of coloration seen within the range ascribed to this race. The change toward the relatively pallid tone of color possessed by the members of the race *vallicola* at the south end of the San Joaquin Valley is very gradual. In the region of San Joaquin and Mariposa counties at the southern margin of the range of *audubonii* a somewhat paler color is seen on the subterminal band of the dorsal guard hairs. Correlated with this is a reduction in the length of the apical band of black. More noticeable in this region, however, is the lighter color of the tops of the fore legs and lower parts of the hind legs which more nearly approach the condition seen in *vallicola*. Cottontails from the mouth of the Salinas River in Monterey County resemble in color those from the north end of the San Joaquin Valley.

The change from *auduboni* to *vallicola*, in regard to the cranial characters studied, is likewise very gradual. In the San Francisco Bay region, there is a reduction in zygomatic breadth (ratio to basilar length for 8 adults, 63.3 per cent) as seen in *vallicola*. The rostrum

shows only a slight tendency to become narrower basally, as seen by the ratio of breadth to length of nasals (47.4 per cent as compared with 48.0 per cent in the northern Sacramento Valley and 44.5 per cent in the southern San Joaquin Valley). The length of the molar series averages 24.4 per cent of the basilar length—a very slight reduction from the ratio for Sacramento Valley specimens (see table 3). Skulls examined from the southern margins of the range of *audubonii*, in the northern San Joaquin Valley and lower Salinas Valley, exhibit the same narrow zygomatic breadth, and, additionally, a

TABLE 3

CRANIAL RELATIONSHIPS EXPRESSED IN PERCENTAGES FOR THE VARIOUS RACES OF
Sylvilagus audubonii OCCURRING IN CALIFORNIA

	Ratio of zygomatic breadth to basilar length		Ratio of length of nasals to basilar length		Ratio of width of nasals to length of nasals		Ratio of palatal length to basilar length		Ratio of length of molar series to basilar length	
	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀
<i>S. a. audubonii</i>	65.5	65.9	55.5	55.3	48.0	48.0	10.4	10.5	24.7	24.6
<i>S. a. vallicola</i>	64.3	63.2	56.6	55.6	44.6	44.5	10.5	10.3	23.7	23.7
<i>S. a. sanctidiegi</i>	65.3	65.1	57.5	57.9	45.1	45.9	10.3	10.6	24.4	24.7
<i>S. a. arizonae</i>	65.3	65.1	56.2	53.8	45.1	45.9	10.3	10.6	24.4	24.7

relatively shortened molariform series. Similarly, the ears show a slight increase in length. The rostrum, however, remains proportionately broad as seen in those from the San Francisco Bay region and farther north.

Measurements.—The average and extreme measurements of 5 adult males from Tehama, Butte and Yolo counties are as follows: Total length, 385.4 (372–397); tail vertebræ, 56.0 (45–60); hind foot, 88.6 (83–94); ear from notch (2 specimens), 70–71; ear from crown (4 averaged), 84.0 (81–86); basilar length, 53.0 (52.0–54.1); zygomatic breadth, 34.7 (33.9–35.2); postorbital constriction, 11.8 (11.0–12.6); length of nasals, 29.4 (28.2–30.4); width of nasals, 14.0 (13.2–15.4); length of molar series, 13.1 (12.1–12.6); diameter of external auditory meatus, 4.4 (4.2–4.5); breadth of brain-case, 22.6 (21.6–23.6); length of palatal bridge, 5.5 (5.1–5.9). The average and extreme measurements of 7 adult females from Tehama, Butte and Yolo counties are as follows: Total length, 385.4 (375–400); tail vertebræ, 51.3 (39–56); hind foot, 90.1 (81–93); ear from notch (4 averaged), 72.8 (72–75); ear from crown (6 averaged), 84.0 (80–90);

basilar length (6 averaged), 53.2 (51.9–54.5); zygomatic breadth, 35.2 (34.0–36.7); postorbital constriction, 12.2 (11.2–12.8); length of nasals, 29.4 (27.7–31.0); width of nasals, 14.1 (12.7–15.9); length of molar series, 13.1 (12.2–14.3); diameter of external auditory meatus, 4.4 (3.9–4.7); breadth of brain-case (6 averaged), 22.4 (21.6–23.2); length of palatal bridge, 5.6 (5.0–6.1).

Weights.—The average and extreme weights of 3 adult males from Tehama and Butte counties are 841.0 (755.7–907.5) grams. The average and extreme weights of 4 adult females from Tehama and Butte counties are, 988.5 (883–1250) grams.

Specimens examined.—A total of 71 from the following localities: Tehama County: Paine's Creek, 600 feet altitude, 1; near Red Bluff, 300 feet altitude, 3. Butte County: Butte Creek, 4 miles southeast of Chico, 1; Llano Seco Rancho, southeast of Chico, 8. Glenn County: Winslow, 5 miles west of Fruto, 3. Yuba County: Rackerby (coll. Calif. Acad. Sci.), 1. Sutter County: Butte Slough, 1 mile west of Butte, 1. Yolo County: Rumsey, 2; Grand Island, 2 miles north of Knights Landing, 2. San Joaquin County: 6 miles southwest of Galt, Tracy Lake, 3; Corral Hollow, 8 miles southwest of Tracy, 1. Contra Costa County: near Albany, 2; Lafayette (coll. Calif. Acad. Sci.), 2; 2 miles southwest of Walnut Creek, 4; 2 miles northeast of Moraga, Moraga Valley, 1. Alameda County: Berkeley, 1; Livermore (coll. Calif. Acad. Sci.), 1. San Francisco County: San Francisco (1 in coll. Calif. Acad. Sci.), 2. San Mateo County: Redwood City, 4; Menlo Park, 4. Stanislaus County: 2 miles northeast of Vernalis, 1; La Grange, 1; Turlock, 1. Merced County: Snelling, 4. Mariposa County: Pleasant Valley, 1; Varain, 3. Monterey County: 2 miles south of mouth of Salinas River (2 in coll. Calif. Acad. Sci.), 8.

***Sylvilagus audubonii vallicola* Nelson**

Plate 6, figure 2; Plate 7, figure 2

Lepus sylvaticus auduboni, TRUF (1885, p. 601), part.

Lepus sylvaticus arizonae, TRUE (1885, p. 601), part; BRYANT (1891, p. 358), part.

[*Sylvilagus*] *auduboni*, TROUSSART (1904, p. 538), part.

Lepus auduboni, ELIOT (1905, p. 345), part.

Sylvilagus auduboni vallicola NELSON (1907, p. 82), original description; NELSON (1909, p. 216).

Sylvilagus audubonii vallicola, MILLER (1912, p. 365).

Type.—Adult female, skin and skull; No. 31257/43122, United States National Museum, Biological Survey collection; from San Emigdio Ranch, Kern County, California; collected October 22, 1891, by Edward W. Nelson; original No. 1353.

Geographic distribution.—From central Monterey County, south, through the upper Salinas Valley to the Cuyama Valley; inland, inhabiting the southern half of the San Joaquin Valley from southwestern Merced County to the Tehachapi and San Emigdio ranges (fig. 19). Zonal range, mostly Lower Sonoran, extending locally into Upper Sonoran. Altitudinal range from near sea level up to approximately 4000 feet.

Diagnosis.—Size, large, with ears relatively long; color, pale in comparison with *audubonii* or *sanctidiegi*, but somewhat more yellowish than *arizonæ*; gray rump patch noticeable; pelage of somewhat finer texture than in *audubonii*; skull, large, with rostrum proportionately slender; auditory bullæ of medium size.

Adult fall pelage.—The following description is based upon an average specimen selected from a series taken at Buttonwillow, Kern County. Decidedly paler in general than *Sylvilagus a. audubonii* with terminal band of black on guard hairs of dorsal parts reduced in extent; subterminal band of guard hairs on back and top of head nearly light buff; gray rump patch present although not as conspicuous as in *arizonæ*; long hairs on anterior rims of ears whitish; hairs on inner posterior parts of ears becoming only slightly buffy at extreme distal tips of ears; nape between clay color and cinnamon-buff; tops of fore legs between cinnamon-buff and pinkish cinnamon; hind legs above heels slightly brighter than pinkish buff; tops of hind feet whiter than in *audubonii*.

Skull (pl. 6, fig. 2; pl. 7, fig. 2).—Size, large; rostrum of medium length, but tapering from a narrow base; zygomata not widely expanded; brain-case more elongate than in *audubonii*; jugals relatively slender; anterior palatine foramina proportionately long; palatal bridge of medium length; auditory bullæ slightly larger than seen in *audubonii*; molar series relatively short.

Compared with *sanctidiegi*, *vallicola* possesses a rostrum which is more slender basally, has less widely expanded zygomata, slightly heavier jugals, a shorter palatal bridge and shorter molar series. For further comparisons see *audubonii* and *arizonæ*.

Remarks.—The race *vallicola*, as here understood, consists of cot-

tontails occupying a very broad area of intergradation between the races *auduboni* and *arizonæ*, both of which possess many characters developed to the opposite extreme for the species in California. The area is so extensive and the change, in regard to characters studied, so gradual in many instances that to eliminate the name *vallicola* would be impractical. In so far as was determined *vallicola* was not seen to possess any distinctive characters, either externally or cranially, which would set it apart from the more northern and southern races with which it comes into contact. As regards body size, basilar length and length of rostrum it varies but little from *auduboni*, whereas, in respect to such characters as color, length of molariform series and width of nasals, it is seen to be nearly intermediate between *auduboni* and *arizonæ*. The ear length of *vallicola* from the southern San Joaquin Valley is equal to, if not slightly longer than, that of typical *arizonæ*, although the auditory bullæ fail to show a corresponding increase in size, being only slightly larger than in *auduboni*.

Specimens from central Fresno County exhibit an intermediate condition between *auduboni* and *vallicola* in color, shape of rostrum and size of auditory bullæ. In the Salinas Valley a gradual transition is evident, in regard to color, from a dark *auduboni* type at the northern end to a color in southern Monterey and extreme western Fresno counties which is identical with that seen in the southern San Joaquin Valley. In the vicinity of Soledad, Monterey County, the color is intermediate between that of the two races. With respect to cranial characters, a series of six adult males from the upper Salinas Valley show a close approach to typical *vallicola* as may be seen by comparing the following ratios with those given in table 3: ratio of breadth of nasals to length of nasals, 45.8 per cent; ratio of zygomatic breadth to basilar length, 63.8 per cent; ratio of length of molariform series to basilar length, 23.9 per cent. Six adults in fresh winter pelage from Walker Basin, Kern County, agree with typical *vallicola* in cranial characters, showing, however, considerable variation in color. Some of these specimens show a close approach to *arizonæ* as seen by the pinkish tone of pelage. The palest example seen of this race is an adult from the Cuyama Plains, Santa Barbara County.

Measurements.—The average and extreme measurements of 13 adult males from southern Tulare and southwestern Kern counties

are as follows: Total length, 389.7 (375–406); tail vertebræ, 51.4 (40–67); hind foot, 88.9 (84–92); ear from notch (5 averaged), 78.6 (77–81); ear from crown (9 averaged), 95.3 (92–102); basilar length, 53.2 (51.3–55.7); zygomatic breadth, 34.2 (33.2–34.9); postorbital constriction, 12.0 (10.4–13.4); length of nasals, 30.1 (28.5–31.5); width of nasals, 13.4 (12.6–14.6); length of molar series, 12.6 (12.1–13.1); diameter of external auditory meatus, 4.7 (4.3–5.4); breadth of brain-case (12 averaged), 22.6 (22.0–23.6); length of palatal bridge, 5.6 (4.7–6.3).

The average and extreme measurements of 9 adult females from southwestern Kern County are as follows: Total length, 409.1 (390–434); tail vertebræ (8 averaged), 52.2 (40–64); hind foot, 89.7 (85–93); ear from notch (3 averaged), 81.3 (81–82); ear from crown (4 averaged), 94.5 (92–97); basilar length (7 averaged), 54.1 (53.0–55.1); zygomatic breadth (8 averaged), 34.2 (33.2–35.0); postorbital constriction, 11.6 (10.4–12.6); length of nasals, 31.0 (29.4–33.9); width of nasals, 13.8 (13.2–14.8); length of molar series, 12.8 (12.5–13.1); diameter of external auditory meatus (8 averaged), 4.5 (4.2–4.9); breadth of brain-case (7 averaged), 22.9 (22.3–23.5); length of palatal bridge, 5.6 (5.2–6.1).

Weights.—The average and extreme weights of 7 adult males from southwestern Kern County are 912.2 (835.0–987.5) grams. The weights of 2 adult females from southwestern Kern County are 1096 and 1190.8 grams.

Specimens examined.—A total of 86 from the following localities: Merced County: Los Banos (coll. Calif. Acad. Sci.), 1; Sweeney's Ranch, 22 miles southwest of Los Banos, 4. Madera County: Raymond, 940 feet altitude, 3. San Benito County: Cook, 1300 feet altitude, Bear Valley, 1; Hernandez, 1. Monterey County: near Soledad (1 in coll. Calif. Acad. Sci.), 4; Jolon, 2; 2–2½ miles east of Bryson, 1500 feet altitude, 5; Bryson (coll. Calif. Acad. Sci.), 1. Fresno County: Lane Bridge, 10 miles north of Fresno, 2; 1½ miles north of Mendota, 176 feet altitude, 1; 12 miles west of Fresno, 3; Minkler, 2; Dunlap, 2; Panoche Creek, B.M. 503, 1; Waltham Creek, 4½ miles southeast of Priest Valley, 1850 feet altitude, 2. Tulare County: Tipton, 266 feet altitude, 1; 1 mile north of Earlimart, 1; 7 miles north of Springville, 2100 feet altitude, 1. Kern County: Fay Creek, 6 miles north of Weldon, 4100 feet altitude, 2; Onyx, 2750 feet altitude, 2; Isabella, 2500 feet altitude, 3; Bodfish, 2400 feet altitude, 2;

Thompson Canyon, Walker Basin, 3500–3900 feet altitude, 5; near Buttonwillow (8 in coll. Calif. Acad. Sci.), 14; McKittrick, 1111 feet altitude, 1; east side of levee, Buena Vista Lake, 298 feet altitude, 1; 8 miles west of 20 miles south of Bakersfield, 1; San Emigdio Creek, 8; Fort Tejon, 1. Santa Barbara County: Cuyama Plains (coll. Calif. Acad. Sci.), 1. Ventura County: Mt. Pinos, 3; Cuddy Canyon, 4.

***Sylvilagus audubonii sanctidiegi* Miller**

Plate 6, figure 3; Plate 7, figure 3

Lepus sylvaticus var. *auduboni*, ALLEN (1875, p. 434), part.

Lepus sylvaticus auduboni, TRUE (1885, p. 601), part.

Lepus floridanus sanctidiegi MILLER (1899, p. 389), original description.

Lepus auduboni sanctidiegi, ELLIOT (1901, p. 283), part.

[*Sylvilagus*] *auduboni*, TROUESSART (1904, p. 538), part.

[*Sylvilagus auduboni*] *sanctidiegi*, TROUESSART (1904, p. 538).

Sylvilagus (Sylvilagus) floridanus sanctidiegi, LYON (1904, p. 336).

Lepus sanctidiegi, ELLIOT (1905, p. 345).

Sylvilagus auduboni sanctidiegi, NELSON (1909, p. 218).

Sylvilagus auduboni sanctidiegi MILLER (1912, p. 366).

Type.—Adult female, skin and skull; No. 60668, United States National Museum; from near Monument No. 258 (Pacific Ocean), Mexican boundary line, San Diego County, California; collected July 10, 1894, by Dr. Edgar A. Mearns, United States Army; original No. 3783.

Geographic distribution.—Coastal southern California, west of the crests of the coast ranges, from Ventura County south to Lower California (fig. 19). Zonal range. Lower and Upper Sonoran. Altitudinal range, from sea level to more than 1000 feet.

Diagnosis.—Similar to *Sylvilagus a. audubonii* in respect to large size, short ear length, dark coloration and harsh quality of pelage; skull, closely resembling that of *audubonii* from which it may be distinguished by the following characters: rostrum longer and relatively narrower at base, jugals more slender and palatal bridge longer.

Adult fall pelage.—The following description is based upon an average specimen from San Diego, San Diego County. Very similar to *Sylvilagus a. audubonii* but averaging slightly darker; nape ochraceous-tawny; tops of fore legs a trifle brighter than in *audubonii*; buffy color seen on tops of hind feet between toes tending to extend

farther back in *sanctidiegi* than in other races of *audubonii* occurring in California.

Skull (pl. 6, fig. 3; pl. 7, fig. 3).—Size, large; rostrum about intermediate in shape between that of *audubonii* and that of *vallicola*, although nasals are longer, in proportion to basilar length, than in either of these races; zygomata rather widely expanded; jugals proportionately slender; anterior palatine foramina relatively short and broad; palatal bridge long; auditory bullæ averaging slightly larger than in *audubonii*; molar series long.

When skulls of *sanctidiegi* from the southern coastal area are compared with those of *audubonii* from the northern Sacramento Valley the main differences to be noted are as follows: *sanctidiegi* possesses a more elongate rostrum which is relatively narrower at base, a longer palatal bridge and more slender jugals.

Remarks.—The subspecific characters ascribed to the race *sanctidiegi* from coastal southern California differ so little from those of *audubonii* from northern California that, if it were not for their geographic separation, there would hardly be justification for the application of separate subspecific names. The size differences are only average ones and practically fall within the range of individual variation. The color differences are even more difficult to discern. Nelson (1909, p. 218) expressed the opinion that *sanctidiegi* was somewhat paler than *audubonii*. The material used in this study indicates the reverse, namely, that *sanctidiegi* is inclined to be very slightly darker than *audubonii*. Considering that *sanctidiegi* is more strictly coastal in distribution than *audubonii* which, for the most part, inhabits the dry Sacramento Valley, and that dark coloration and proximity to the coast seem to be correlated in California, this would normally be expected.

This typical dark coloration is manifested only in the immediate vicinity of the coast from Ventura County south to San Diego County. Farther east along the western slopes of the coast ranges there is tendency toward a paler coloration. This condition is true of specimens from Colton, San Bernardino County, Vallivista, Riverside County and central San Diego County. Two specimens in fresh pelage from San Felipe Canyon, San Diego County, are intermediate, in respect to color, between *sanctidiegi* and *arizonæ*, if anything, approaching closer to the desert race.

As regards cranial features, the change from *sanctidiegi* to *ari-*

zonæ is first noted in the more eastern population of *sanctidiegi* as a diminution in size which, to a certain extent, is correlated with a lesser total length of body. The reduction, however, in size of skull is of greater degree than that of body length as we go from west to east. Farther east than the point at which reduction in size of skull occurs, a decrease in width of base of rostrum and in zygomatic breadth is seen. Still farther east, increase in size of auditory bullæ takes place. The last three changes are considered more in detail under the race *arizonæ* (see p. 124). Color is, of course, the first character to change. Cottontails from near Colton, San Bernardino County, although considerably paler than those from the coast, do not show appreciable cranial differences distinguishing them from the latter. Specimens from Vallivista, Riverside County, and from San Felipe Canyon, San Diego County, in addition to their somewhat pallid coloration, possess skulls with a basilar length most closely resembling that of *arizonæ*. In three other characters, namely, shape of rostrum, zygomatic breadth and size of auditory bullæ, they differ but little from *sanctidiegi* and accordingly are here included with this race.

Measurements.—The average and extreme measurements of 9 adult males from Los Angeles and San Diego counties are as follows: Total length, 389.2 (360–410); tail vertebræ, 46.4 (30–55); hind foot, 86.8 (80–90); ear from crown (6 averaged), 86.0 (80–92); basilar length, 53.0 (51.3–55.7); zygomatic breadth (8 averaged), 34.6 (33.4–35.9); postorbital constriction, 12.1 (11.1–12.8); length of nasals, 30.5 (29.3–31.8); width of nasals, 14.4 (13.7–15.3); length of molar series, 13.0 (12.1–13.5); diameter of external auditory meatus, 4.4 (3.9–4.7); breadth of brain-case, 22.9 (22.4–23.4); length of palatal bridge, 5.9 (5.4–6.4). The average and extreme measurements of 11 adult females from coastal Los Angeles and San Diego counties are as follows: Total length (10 averaged), 395.8 (380–418); tail vertebræ (10 averaged), 57.8 (48–69); hind foot (10 averaged), 86.1 (80–90); basilar length (10 averaged), 53.6 (52.2–55.3); zygomatic breadth, 34.7 (34.0–35.4); postorbital constriction, 12.1 (11.0–13.5); length of nasals, 31.0 (29.0–33.0); width of nasals, 14.2 (13.2–15.3); length of molar series, 13.2 (12.9–13.5); diameter of external auditory meatus, 4.5 (3.8–4.8); breadth of brain-case (9 averaged), 23.2 (22.4–23.9); length of palatal bridge, 5.9 (4.6–6.6).

Specimens examined.—A total of 56 from the following localities:

Ventura County: Sespe, 1; Ventura, 5. San Bernardino County: Reche Canyon, near Colton, 5. Los Angeles County: near Pasadena, 10; Monrovia (coll. Calif. Acad. Sci.), 4. Riverside County: Vallivista, 2. San Diego County: Warner Pass, 1; San Marcos (1 in coll. Calif. Acad. Sci., 3 in collection Ralph Ellis), 4; Escondido (1 in collection Ralph Ellis), 2; Witch Creek, 2; Julian, 5; San Felipe Canyon, 2; Cuyamaca Mountains, 1; San Diego, 3; Point Loma, 2; Chula Vista, 1; Otay Valley, 1; Tijuana River, 3; Dulzura, 2.

***Sylvilagus audubonii arizonæ* Allen**

Plate 6, figure 4; Plate 7, figure 4

Lepus sylvaticus var. *auduboni*, ALLEN (1875, p. 434), part.

[*Lepus sylvaticus*] var. *arizonæ* ALLEN (1877, p. 332), original description.

Lepus sylvaticus arizonæ, TRUE, (1885, p. 601), part.

Lepus arizonæ, MERRIAM (1890, p. 76); ELIOT (1905, p. 349).

Lepus auduboni sanctidiegi, ELLIOT (1901, p. 283), part.

Lepus laticinctus ELLIOT (1903, p. 254).

Lepus [*laticinctus*]. *rufipes* ELIOT (1903*b*, p. 254).

Sylvilagus (*Sylvilagus*) *arizonæ*, LYON (1904, p. 336).

Sylvilagus arizonæ, LYON and OSGOOD (1909, p. 31).

Sylvilagus auduboni arizonæ, NELSON (1909, p. 222).

Sylvilagus audubonii arizonæ, MILLER (1912, p. 367).

Type.—Adult male, skin only (no record of skull, *vide* Lyon and Osgood, 1909, p. 31); No. 8439, United States National Museum; from Beale [Beall's, or Beal] Spring, 3 miles northwest of Kingman, Mohave County, Arizona; collected September 8, 1865, by Dr. Eliott Coues; original No. 1563.

Geographic distribution.—The desert regions of southeastern California from near Benton Station, Mono County, south through Inyo County to and including, the Mohave and Colorado deserts (fig. 19). Zonal range, Lower Sonoran. Altitudinal range, from below sea level, as in Death Valley, to nearly 6000 feet.

Diagnosis.—Size, small; ears proportionately very long; pelage of soft texture, possessing a pinkish tinge in mass effect; pale gray rump patch conspicuous; skull, small, with rostrum rather slender; auditory bullæ actually as well as relatively larger than in any other race of this species in California.

Adult fall pelage.—In general, much paler than either *audubonii* or *sanctidiegi* and of a more pinkish tone in contrast to *vallicola*; pelage very soft in contrast to the other three races herein considered.

The following description is based upon an average specimen from the west side of the Colorado River near the California-Nevada boundary line, Nevada. Subterminal band of overhairs on back and top of head pinkish-buff; apical band of black about as in *vallicola*; rump conspicuously gray with subterminal band of guard hairs white; hairs on anterior rims and inner posterior parts of ears near tips more nearly white than in *audubonii*; nape somewhat paler than pinkish-cinnamon; tops of fore legs nearest pinkish-cinnamon but paler; backs of hind legs above heels between light ochraceous-buff and light pinkish-cinnamon; hind feet more heavily haired than in *audubonii*.

Skull (pl. 6, fig. 4; pl. 7, fig. 4).—Size, small; rostrum of medium length, tapering from a moderately narrow base; brain-case rather narrow; zygomatic breadth somewhat greater, relatively, than in *vallicola*; jugals slender; anterior palatine foramina short; palatal bridge of medium length; auditory bullæ large, both actually and relatively; molar series proportionately long.

This race differs cranially from both *vallicola* and *sanctidiegi* by its smaller size and possession of very large auditory bullæ. From *vallicola* it may further be distinguished by a relatively greater zygomatic breadth (although actually less) and a relatively longer tooth row. Other characters distinguishing *arizonæ* from *sanctidiegi* are possession by the former of relatively shorter nasals and shorter palatal bridge.

Remarks.—There is considerable color variation throughout the range of the race *arizonæ*. In the Owens Valley region from southern Mono County, south to Keeler, Inyo County, there is a tendency toward a more yellowish coloration on the guard hairs than is seen on animals from other parts of the range of *arizonæ*. This tendency toward *vallicola* is also indicated in the relatively small size of the auditory bullæ. With respect to other cranial proportions and size of body, cottontails from this area agree with *arizonæ*.

Only three specimens were examined from the west side of Walker Pass—all in worn pelage. The skulls of two of these are unusually small with proportionately small auditory bullæ. The other skull is of average size for members of this race and possesses relatively large bullæ. An adult in fresh pelage taken in Kelso Valley, Kern County, is quite similar to specimens from Owens Valley.

The manner of change in cranial characters from *vallicola* to *ari-*

zonæ essentially resembles the change from *sanctidiegi* to *arizonæ*. Specimens arranged geographically across the areas of intergradation show first a great reduction in size of skull. This is followed by a decrease in relative breadth of base of rostrum and of zygomatic breadth and, finally, by a marked increase in size of auditory bullæ. The latter ultimately appear very much inflated in typical skulls of the race *arizonæ*.

A careful study of 11 specimens, 9 of them adults, from Death Valley, Inyo County, has shown that cottontails from this region differ slightly from those from other localities within the range of this race. The ears average somewhat longer, although a corresponding increase in size of auditory bullæ is not evident. Another feature characteristic of cottontails from Death Valley is their extremely pallid coloration and most pronounced ashy gray rump patch. These characters while slight, too slight I believe to warrant the use of the name *rufipes* proposed by Elliot (1903*b*, p. 251), are constantly present and of distinct interest from the standpoint of geographic variation.

Specimens from the west side of the Colorado River, near Needles, San Bernardino County, have been considered as typical of this race, agreeing closely with the description given by Nelson (1909, pp. 222-223) for *arizonæ*. One adult from 4 miles southwest of Dolan's Spring, Mohave County, Arizona, not far from the type locality, shows no appreciable difference from those of the series from the west side of the Colorado River.

Seven adults, in worn pelage, from near Salton Lake and along the Alamo and New rivers, Imperial County, exhibit a decidedly reddish tone of coloration as was noted of other specimens of cottontails from this region by Nelson (*op. cit.*, pp. 224-225). This is probably not as marked in new pelage, more than likely being mostly the result of the action of extremely alkaline soil upon the hair for many months. Winter-taken skins of adults from near the Alamo River just south of the border of Lower California are but slightly more reddish than comparable skins from north along the Colorado River in San Bernardino County.

Along the western edge of the Mohave and Colorado deserts members of this race, while pale in color and possessing small skulls, show a distinct decrease in size of auditory bullæ. This condition is seen in specimens from Fairmont, Antelope Valley, and Palm Springs, Riverside County. Still farther west along the eastern slopes of the

southern coast ranges, the rostrum becomes broader basally, the zygomatic breadth greater as in *sanctidiegi* and the color darker, intermediate between that of the coastal and desert races (see Remarks under *sanctidiegi*, p. 121).

Measurements.—The average and extreme measurements of 6 adult males from the west side of the Colorado River from near the California-Nevada boundary line in Nevada south to the Riverside Mountains, Riverside County, are as follows: Total length, 351.3 (340–372); tail vertebræ, 40.7 (35–48); hind foot, 85.0 (80–88); ear from notch (4 averaged), 78.0 (77–80); ear from crown (3 averaged), 88.7 (86–90); basilar length, 50.5 (48.1–51.7); zygomatic breadth (5 averaged), 33.0 (32.4–33.5); postorbital constriction, 11.9 (11.4–13.0); length of nasals, 28.4 (26.7–31.4); width of nasals (5 averaged), 12.8 (12.4–13.5); length of molar series, 12.3 (11.7–12.7); diameter of external auditory meatus, 4.9 (4.4–5.2); breadth of brain-case, 21.7 (21.0–22.7); length of palatal bridge, 5.2 (4.5–5.7).

The average and extreme measurements of 6 adult females from the west side of the Colorado River from near the California-Nevada boundary line in Nevada south to the Riverside Mountains, Riverside County, are as follows: Total length, 355.2 (340–375); tail vertebræ, 42.3 (33–53); hind foot, 81.8 (78–88); ear from notch (3 averaged), 85.0 (78–89); ear from crown (1 specimen), 96.0; basilar length, 49.8 (49.4–51.5); zygomatic breadth, 32.4 (31.8–33.2); postorbital constriction (5 averaged), 11.6 (11.1–12.6); length of nasals, 26.8 (26.5–27.9); width of nasals, 12.3 (11.8–13.3); length of molar series, 12.3 (11.8–12.6); diameter of external auditory meatus (5 averaged), 4.6 (4.1–4.9); breadth of brain-case (5 averaged), 21.5 (21.3–21.8); length of palatal bridge, 5.3 (4.9–6.2).

Weights.—The average and extreme weights of 4 adult males from the west side of the Colorado River near the California-Nevada boundary line, Nevada, are 708.7 (636.5–770.5) grams. The weights of 2 adult females from the same locality are 678.9 and 743.0 grams.

Specimens examined.—A total of 78 from the following localities: Mono County: near Benton, 5300–5639 feet altitude, 4; Oasis, 5000 feet altitude, 1. Inyo County: 2 miles west of Laws, 2; Bishop (collection Ralph Ellis), 1; Independence, 3900 feet altitude, 1; near Lone Pine Creek (2 in collection Ralph Ellis), 3; Tuttle Creek, 4500 feet altitude, 1; Keeler, 3604 feet altitude, 1; near Furnace Creek Ranch, Death Valley, —178 feet altitude, 11; Little Lake, 3100 feet altitude,

1. Kern County: west slope of Walker Pass, 4600 feet altitude, 3; northwest part of Kelso Valley, 4200 feet altitude, 1. Los Angeles County: Fairmont, Antelope Valley, 2. San Bernardino County: Victorville, 1; Cushenberry Springs, San Bernardino Mountains, 4; Cactus Flat, San Bernardino Mountains, 1; west side of Colorado River, opposite The Needles, 1; 29 miles south of Needles (collection Ralph Ellis), 2; Oro Grande, 2. Riverside County: Banning, 1; Palm Springs, 1; Indio (coll. Calif. Acad. Sci.), 1; Mecca, 6; Riverside Mountains, 9; Blythe, 2. San Diego County: Vallecito, 1. Imperial County: Salt Creek, 2; Salton Sea, 3; New River, near Salton Sea, 1; Brawley, 1; 6 miles west of Imperial, 1; Silsbee, 1; west side of Colorado River opposite Cibola, 2; 8 miles east of Picacho, 1; 5 miles northeast of Yuma, 1; near Pilot Knob, 1.

LIFE HISTORY

Among the various species of rabbits inhabiting western North America the Audubon cottontail is probably exceeded only by the black-tailed jack rabbit in ability to exist under many different environmental conditions. In zonal distribution the range of this species extends from Upper Sonoran (locally, even Transition) in northern California to Arid Tropical in the Cape region of Lower California. On the Great Plains of the Middle West its range overlaps that of the eastern cottontail (*Sylvilagus floridanus*). In general, however, the Audubon cottontail may be considered as an inhabitant largely of the Lower Sonoran Life Zone. The greater portion of its range in California occupies the interior valleys and southeastern deserts.

Along the lower limits of the chaparral belt of the inner and southern coast ranges and of the Sierra Nevada foothills cottontails may be found mutually occupying cover with brush rabbits. Unlike the latter they never penetrate far into chaparral areas. Cottontails are equally capable of existing in open grass land and desert where shelter is most often derived from burrows.

Along the Sacramento River bottom land in Butte County, southwest of Chico, cottontails were noted in brushy tracts composed chiefly of willow (*Salix* spp.), buttonwillow (*Cephalanthus occidentalis*) and wild grape (*Vitis californica*). Rabbits were observed only in patches of brush adjacent to clearings or meadow land.

In the Berkeley Hills, above the University of California, cottontails were seen to be largely confined to more open hillsides rather than brushy canyons. They were noted most often near occasional patches of arroyo willow (*Salix lasiolepis*).

Along the inner coast range, in western Fresno County, cottontails were rather commonly seen at the edges of brushland, consisting principally of chamise (*Adenostoma fasciculatum*), also on hillsides where loose stands of chamise were intermingled with certain other



Fig. 20—Patches of wild rose such as often provide shelter and, to a certain extent, food for cottontails inhabiting the floor of the San Joaquin Valley in northern Stanislaus County, California. Photograph taken November 4, 1932

plants such as *Eriodictyon crassifolium* and *Eriogonum* sp. They were quite numerous on open grassy hillsides, in creek bottoms and along dry gullies where there was little or no vegetation cover.

Most of the field observations made on this species were obtained along the west side of the San Joaquin River, in San Joaquin and Stanislaus counties, between the years of 1930 and 1932. Streamside associations were found extremely suitable for cottontail habitation. The dominant tree growth forming part of these associations consisted principally of valley oak (*Quercus lobata*), black willow (*Salix nigra*) and, occasionally, cottonwood (*Populus fremonti*). Beneath these trees were dense jungles of wild rose (*Rosa californica*) (fig. 20) and blackberry (*Rubus vitifolius*). Thickets of sandbar willow (*Salix sessilifolia*) were sometimes present. Frequently *Baccharis douglassii* was noted growing along the outer margins of such associations. Dur-

ing the spring and summer months coves along the edges of this brushland often contained growths of nettle (*Urtica gracilis*) and sedge (*Carex*) as well as grass. Where the jungleland was relatively broad and dense, extending back three or four hundred yards from the river, whose course it paralleled, only the outer margins were found to be inhabited by cottontails. Thorough search in the center of such tangles failed to show any signs of rabbits either in the form of tracks, trails or droppings. Clearings were apparently essential for the presence of members of this species. As a general rule a short ways from the river the brushland became more penetrable with open, grassy spaces alternating frequently with patches of brush. The greatest numbers of individuals were noted in these situations and along the margins of the brush next to meadow land. Accumulated drift occasionally was found as suitable as vegetation for occupancy by rabbits. A number of cottontails were seen living in the nearby fields, especially along gullies. These animals frequented burrows which were either out in the open or, as was more often the case, situated beneath solitary black willows or at the bases of old dead stumps.

Near Earlimart, Tulare County, cottontails were commonly found living in old squirrel holes in the "hog-wallow land" (Dixon, MS). Dice (1926, p. 20) speaks of cottontails on the floor of the San Joaquin Valley in Fresno County, as living "under old buildings, about lumber and brush piles, and in old weedy fields." He likewise mentions an instance where a cottontail was seen at dusk in an open field of short grass at least one-quarter of a mile from brush or high weeds. Individuals of this species were observed by the present writer in Juniper and *Chrysothamnus* associations near Bodfish, Kern County.

Along the Colorado River in southern Nevada, cottontails were observed near arrow-weed (*Pluchea sericea*) associations, on the floors of dry washes where screw-bean mesquite (*Prosopis pubescens*) and catclaw (*Acacia greggii*) provided suitable cover, also about the bases of rocky canyon walls.

GENERAL HABITS AND BEHAVIOR

Forms, burrows and trails.—Cottontails inhabiting open situations appear to frequent burrows during the major portion of their daily periods of inactivity. In certain instances, however, individuals of this species may be found in forms even where they are living away

from brushy cover. These forms often resemble those of jack rabbits in that they merely consist in cleared spaces, situated in tall grass, which are of sufficient size to harbor single individuals. None of the forms examined gave evidence of having the earth excavated even to a slight extent. In nearly every instance the bottom of the form contained some matted-down grass and a few droppings. Short but definite trails appeared to lead out a few feet from these structures. These forms were found both in open stands of tall grass and in grass beneath small trees.

Burrows, inhabited by cottontails living away from brush, were most often found to be situated close to the roots of small trees such as willows. The low branches of this arboreal vegetation afforded a certain amount of protection, helping both to conceal the mouth of the burrow and the entering or emerging occupant. Usually the grass growing close to a burrow entrance was seen to be left untouched so as to provide further protection. Dice (1926, p. 21), in speaking of members of this species in San Diego County, says: "Several were trapped in runways radiating from a burrow among the desert brush on the sides of a small ravine near the Scripps Institute."

The construction of burrows occupied by cottontails has generally been attributed to animals other than the rabbits themselves (*cf.* Nelson 1909, p. 21; Grinnell and Storer, 1924, p. 228). Whether or not this is true was not definitely determined. Certain evidence gathered during this study, however, tends to favor the idea that at times these animals may dig their own burrows. In southern San Joaquin County, on December 18, 1930, a cottontail was roused from a form in a clump of grass at the base of an old willow stump at 1:30 P.M. This individual ran about twenty yards to a burrow in an open field and disappeared. The hole into which it ran very much resembled one of the many squirrel burrows which were also present in the vicinity. A large, fan-shaped pile of earth was present outside. An examination of this burrow on the following morning showed it to be filled in with earth. A new burrow or possibly just a new entrance to the same burrow system was present just a few feet away. A large pile of fresh earth, measuring 39 inches in length, and 39 inches in width across the widest portion, was present outside of the entrance. Footprints of cottontails were numerous on the fresh, moist earth making it appear unlikely that any other species of animal had done this excavating. A number of fresh, shallow excava-

tions were present close by. These looked like places where the soil had been tested to determine the most suitable point for digging. On November 29, 1930, in this same general locality, a careful hunt through an extensive patch of brush, inhabited by cottontails, resulted in the finding of a freshly excavated burrow of sufficient size to harbor an individual of this species. Rabbit tracks were numerous here and observations over a considerable period of time had not shown any squirrels to be living in this area. Possibly this hole had been recently dug by some other mammal, but the abundance of rabbit tracks and absence of signs of other species made it seem probable that a cottontail was responsible for the work.

No single burrow system was found having less than two entrances. In some instances three entrances were noted. The average width and height of the tunnels of five separate burrows measured was found to be five and one-half by seven and three-quarters inches. These measurements were taken just inside the mouths of the burrows.

Although forms are used to some extent by cottontails inhabiting brushland a large percentage of these individuals occupy burrows, as do those living in open country. Several times such burrows were found to be situated at the bases of old burned oak stumps. Dice (1926, p. 18) referring to cottontails near Ball's Ferry, Shasta County, says that "Some burrows were noted under thick brush in the soft alluvial soil of the river banks." In Stanislaus County, on November 1, 1930, a cottontail was disturbed from a dusky-footed wood rat (*Neotoma fuscipes*) nest in a dense willow growth. The animal was living in a hollow on one side of the nest pile. The bottom of this hollow was about six inches above the ground. The cavity was approximately one foot in height and sufficiently deep to hold the rabbit.

Rabbits living in thickets have definite runways leading through the brush. Quite noticeable trails are also seen in marginal vegetation such as sedge and tall grass which often borders the larger plant associations. Individuals inhabiting open country frequently make trails resembling those of ground squirrels. Although these paths become quite indistinct beyond the immediate vicinity of brush or burrows, nevertheless, judging from the distribution of pellets in the open, a definite preference is shown for nearby trails made by cattle, squirrels or other animals.

Characteristic poses and movements.—Although cottontails are exceedingly cautious at all times they appear to be especially wary upon first emerging into the open to feed in the late afternoon. Those individuals inhabiting burrows away from the protection of brush were usually seen to emerge in the manner described as follows: The head was first protruded slightly out of the entrance. After this the posterior portion of the body was drawn up, and the head again moved forward until the ears cleared the burrow. During this time the front feet were edged forward with an alternating movement of the limbs. Following this the rabbit would slowly advance until it was clear of the entrance. As soon as the ears were beyond the mouth of the burrow they were very gradually, at times almost imperceptibly, elevated to an erect position.

Sometimes a rabbit burrow was found to have a short, troughlike runway leading gradually from its entrance to the surface of the ground. Individuals inhabiting such burrows were often seen to sit, hunched up and motionless, in these depressed runways for a number of minutes before going out to forage. On one occasion a cottontail was seen to remain in such a position for a period of twenty minutes. Mounds of excavated earth were usually present in front of rabbit burrows in the open. The inhabitants of these burrows almost invariably ascended to the tops of such mounds immediately after emerging. There they would slowly raise themselves on their hind legs until the body was erect. When in such a posture the fore limbs were left hanging loosely at the sides or in front of the body and the ears were elevated until they were vertical to the ground. In one instance in southern San Joaquin County, an individual was observed in this position for four minutes, slowly turning from side to side pivoting on the soles of its feet. The entire animal rather than just the head was moved around to either side. Failing to detect the presence of any danger it lowered itself slowly until all four feet were on the ground, hopped a few feet away and began to nibble grass.

Observations were made one evening at dusk on the reaction of a cottontail to the approach of a person from a distance. The writer, concealed close to a known inhabited rabbit burrow, observed the occupant to emerge in the previously described manner. When the approaching person was first detected by the rabbit it ran to a second burrow entrance, situated above five feet away from the one out of

which it had just emerged. Here it paused a moment and then dived into the hole. As it entered the ears were lowered before they struck against the top of the burrow. A moment after the rabbit disappeared its head was seen to protrude slightly. It remained in this position a very short time, then disappeared. On November 2, 1930, while driving along a road in Stanislaus County, at 9:30 A.M., a cottontail was seen about one hundred yards from a weed-grown gulch. As the car approached, the rabbit stood upon its hind legs in much the same manner as a ground squirrel. When the machine was ten yards away the animal started to go into a burrow, stopped for a brief instant, then lowered its ears and disappeared from sight.

Cottontails are considerably more wary in the late morning and early evening than they are at dawn or dusk. In the evening as it gets darker individuals living in the open frequently hop to the nearest depression or clump of bushes if not frightened after once emerging. Sometimes they will dash across conspicuous openings to arrive at such places, at other times, especially if down in a gully, from five to twenty yards will be traversed at a time, followed by a brief pause for listening before further progress is made toward the chosen feeding site.

Rabbits which inhabit brush or riparian growth react similarly to those found in open situations even though they are less nocturnal in habits than the latter. As a rule, cottontails first come to the outer margin of such cover where they remain motionless for ten to twenty minutes before emerging into the open to feed. These points where they remain on the lookout for danger usually afford them a view of the surrounding open land. Where feeding sites were located adjacent to shaded sides of brush, cottontails were often seen to emerge from three to ten feet out in the open to watch. In such instances they were seldom noted to sit still for more than five or ten minutes.

Brush-inhabiting cottontails, when alarmed, will invariably run toward the shelter of nearby thickets. Usually when they arrive at the edge of this protective cover they pause, either facing it directly or at a slight angle, until certain of danger, at which time they hop into the brush out of sight. Close approach will reveal them hidden just inside of the outer margin of such thickets. If disturbed further they can be heard penetrating deeper into the cover, after which a dead silence ensues. Those individuals inhabiting burrows in the brush seldom retreat to these hiding places when disturbed after

once coming out to feed. Instead they attempt to elude pursuit in the brush itself.

Cottontails living in burrows out in the open can be heard making a thumping noise when alarmed at night. This appears to be done by the hind feet when they are on hard ground. It is often audible one hundred feet away. Seldom is more than one thump heard at a time, although the writer has on several occasions heard two such thumps given in close succession by a single individual before it ran. Rabbits living in thickets usually thump only when they are further disturbed after once being frightened into shelter. Thumping appears to be resorted to mostly when maximum numbers are out foraging, although sometimes individuals will do so when disturbed during the day. It may be a danger warning to other members of the species in the immediate vicinity. No more than one cottontail was ever heard thumping at a time even though at times a number of individuals were alarmed more or less simultaneously.

When running, members of this species take small bounds into the air in order to clear tufts of grass and other obstacles which may be in their way. As open patches of ground are chosen for running, cottontails seldom appear to travel in a straight line. Individuals were observed at times running as far as 100 yards in the open, pursuing a somewhat zig-zag course. Grinnell and Storer (1924, p. 228) state that in one instance the speed of a running cottontail, observed from a moving railroad train, was estimated to be about 15 miles per hour for a short distance. At dawn or dusk the white tails of these animals appear to be especially prominent as the rest of the body blends well in color with the landscape. Cottontails seen at such times were frequently undiscernable when viewed from the side at a distance of ten yards, whereas individuals which were running directly away from the observer were easily followed by the eye to a distance of seventy yards because of the white tail. Immediately, upon their stopping, however, such rabbits are lost to sight. This may be an adaptation to confuse pursuing enemies. One, upon watching a running cottontail under such circumstances, tends to look only at the conspicuous white tail. When this suddenly disappears, due either to their stopping or veering off their course, the animal seems to vanish completely.

Regarding the behavior of cottontails at night in the presence of a light, Sumner (1931, p. 278) states that they became bewildered

and, if forced away from territory familiar to them, may sometimes be captured by hand. In western Fresno County, on December 25, 1932, the writer came across a cottontail at about one and one-half hours after dark. When the beam of a flashlight was thrown upon this animal it ran slowly up a small incline to a patch of brush. The light seemed to confuse the rabbit as it kept its nose to the ground as though trying to detect a trail by the sense of smell.

Low prominences, such as logs and tree stumps, in cottontail territory were invariably found to have rabbit feces deposited on them. This peculiarity apparently is not limited to this species as it was observed among brush rabbits, and has been noted in the case of the Florida marsh rabbit (Blair, 1936, p. 200). Feces were present on stumps that were as high as eighteen inches above the ground and in one instance an abundance of rabbit droppings were observed on the top of a conical wood rat nest that was about three feet in height. Blair (*loc. cit.*) for lack of a more adequate reason to account for this tendency on the part of marsh rabbits to defecate on such prominences suggest the instinct for sanitation as the motivating influence. This writer is inclined to disagree with that suggestion, as the deposition of feces in the case of the Audubon cottontail is by no means limited to such places. In fact their presence there appears to be more or less accidental, judging from the wide distribution of pellets in cottontail territory. It seems possible that these places are "lookout posts" used by certain individuals after dark. Sumner (1931, p. 278) makes mention of a cottontail at Los Banos, Merced County, which was observed for a period of six weeks to spend most of its resting hours on top of a willow limb five and one-half feet above the ground.

Reaction to each other and to other species.—Audubon cottontails show but little tendency toward gregariousness. Those individuals which live in open fields frequently have their burrows grouped near each other. One may sometimes find four or five inhabited burrows in an area measuring no more than twenty by thirty yards in size. From here it may be one-quarter of a mile to the next group of burrows. Such distribution, however, seems to be due to the particular suitability of these local areas for cottontail occupancy, rather than to a well-developed social instinct on the part of these animals. Likewise, group feeding where four or five individuals will be found in a relatively limited area appears to be accidental to a considerable

extent, due to the unusual attractiveness such places possess. This attraction may be due to localized abundance of food plants or to the protection afforded by these feeding sites.

Repeated observations were made upon cottontails and jack rabbits feeding together. No animosity was ever apparent between individuals of these two species. To cite an instance, at 4:25 P.M. on September 9, 1930, in San Joaquin County, a cottontail and jack rabbit were seen close together, about five yards out from a clump of brush. After first becoming aware of the observer's presence both animals remained motionless at attention for twelve minutes. Following this each began to cleanse itself. This was accomplished by rubbing the tongue over the body and by licking the fore paws (only one being used at a time) and rubbing them over the head. The hind feet were used to scratch the body. When the process of cleansing was completed they each began to eat grass, the distance separating them at this time being about two yards. When the larger animal approached too close to the cottontail the latter hopped a short distance away.

California ground squirrels were noted on occasions foraging within three feet of feeding rabbits, neither one bothering the other. The former species was quite common in most of the areas where observations were made upon cottontails. Although the burrows of the squirrels and rabbits were often located within a few feet of each other in no instance was mutual occupancy of a single burrow by members of both species found to occur. When the soft earth outside of rabbit burrows was smoothed off in the morning an examination for tracks in the midafternoon sometimes showed where squirrels had come to the entrances and stopped. Tracks of the squirrels were never seen to enter these burrows.

Cottontails were found to take advantage of the warning calls of certain other animals indicating the presence of danger. The warning bark of a ground squirrel was invariably heeded, even though the squirrel sometimes was as much as 150 yards away. When making observations on rabbits the writer's presence was often first detected by crows and California jays. The warning cries of these birds when given close to feeding cottontails would either cause the latter to immediately run to shelter, or to remain perfectly motionless poised for instant departure. This heeding, on the part of rabbits, of warning cries of certain birds is apparently of rather widespread occur-

rence. Seton (1922, p. 119) makes note of British rabbits which take advantage of the warning calls of magpies.

From repeated tests and observations the writer is convinced that cottontails rely upon hearing more than sight to detect their enemies. Individuals of this species would often come quite close to the writer when he remained motionless for some time in clearings which were used for foraging. On one occasion a cottontail came to feed within fifteen feet of the observer. At the same time a jack rabbit came loping along slowly and passed within three feet of the latter who was lying motionless in the open. This rabbit stopped a short distance away from the cottontail and also began to feed. Crows and jays flying overhead occasionally gave warning cries which would cause both animals to sit at attention for a few moments. They were, however, unable to detect the source of disturbance. Movements of the observer's fingers passed unnoticed but faint squeaks were instantly detected by both animals.

In one instance the writer was able to rise silently from a reclining to a sitting posture when a cottontail sitting twenty feet away was facing in the opposite direction. This indicated more or less conclusively that movement directly behind the rabbit was not visible to it.

On the morning of November 29, 1930, in San Joaquin County, a slow but steady approach was made to within twenty-five feet of four feeding cottontails. A heavy tule fog which was just rising had so saturated the ground and dry grass with moisture that it was possible to advance without making any noticeable noise. The time was 9:00 A.M. and the slight dissipation of the fog permitted visibility up to a distance of about 30 yards. The rabbits gave no indication that they were aware of a strange presence, one of them coming to feed within ten feet of the observer. A slight noise made purposely, however, attracted their attention instantly and put them on the alert.

The only times that voice was recorded was when individuals were wounded. Then they would often emit short, high-pitched squeals.

FOOD HABITS

Feeding places.—The type of cover that is present in a locality is an important factor influencing the selection of feeding sites by Audubon cottontails. In areas where these animals live out in open fields a long ways from brush they tend to feed in grassy hollows

or minor depressions not far distant from their burrows. Very frequently a preference is shown for gullies or dry washes which prevent them from being seen at any great distance. Where cottontails live close to cultivated fields, containing such crops as alfalfa or grain, the margins of these fields are invariably chosen for feeding grounds.

In regions where cottontails inhabit brushy cover adjacent to open grassland a considerable portion of the late morning and early evening feeding takes place beneath the shelter of the brush. Shrubs are principally eaten at such times. Earlier in the morning and later in the evening the open grassland is resorted to for feeding purposes. Less attempt, however, is made on the part of these brush-inhabiting cottontails to select hollows in this open land for feeding than is true of those animals which live entirely in the open.

Times of feeding.—A number of physical factors were found to affect the daily periods of feeding. Among these may be mentioned habitat, season of the year, fog, rain and wind. Normal days, that is, days not marked by any unusual climatic conditions, were taken as a standard. All times were recorded in relation to sunrise and sunset and in each particular instance an effort was made to indicate, approximately, the relative light intensity where individual rabbits were observed feeding (whether in shadow or sunlight, whether loggy, cloudy or clear, etc.).

The term maximum, as here used in regard to populations, refers to a majority number of individuals in an area. For example, at a locality in southern San Joaquin County, on November 2, 1930, between 3:25 and 3:45 P.M. eight cottontails were observed feeding at various points over an area which was approximately 100 by 120 yards in size. This count was determined by cautious approach to certain selected feeding grounds. The area discussed contained a known total population of eleven rabbits but eight in this instance was considered as maximum. It is probable that the observer or some unknown factor may have frightened the three other individuals into the protective shelter of dense brush before they could be recorded.

Cottontails inhabiting brushy areas where food conditions appeared normal were observed feeding in maximum numbers at about one and one-half hours before sunset. In early winter, however, rabbits in a number of localities in the San Joaquin Valley

were found feeding during most of the daylight hours. Such places were generally lacking to a large extent in food, as a result of intensive sheep and cattle grazing.

Those rabbits which lived in burrows situated in open fields were rarely observed out before sunset and maximum numbers were never seen feeding before dusk. The average time of appearance of the first individual in a "colony" was fourteen minutes after sundown. Within the ensuing fifteen minutes practically every member of such a "colony" would be out of its burrow.

Observation on the night feeding of cottontails was very difficult, especially when attempting to determine whether maximum numbers were out or not. The use of a flashlight afoot proved less satisfactory than observations aided by the headlights of an automobile while driving through territory in which cottontails fed. The main drawback to the latter method, however, was that observations were limited to areas accessible by machine.

Individuals were recorded out in numbers up to three and one-half hours after sunset. No correlation between the times of night feeding and the phases of the moon could be definitely established, although a greater number of rabbits appeared to be out feeding after dark on moonlight nights than on dark nights. It is possible, however, that, just as in the case of brush rabbits, the period of night feeding is considerably longer during the full of the moon than during the remainder of the lunar month.

Maximum numbers were always observed out feeding at dawn, providing the mornings were neither foggy nor windy. The numbers remained nearly constant until one hour after sunrise. From this time on feeding became irregular, although, normally, a few individuals were found out feeding up to three hours after sunrise. It was not determined how long before dawn cottontails came out to feed but, as these animals move out slowly from the shelter of brush to feeding places located farther away from cover and as they were observed out at maximum distances from brush at dawn, it would seem likely that there is considerable pre-dawn feeding.

On winter mornings when low tule fogs so reduced visibility as to render the recognition of objects more than a few feet away impossible, maximum numbers were not observed out until ten minutes before sunrise. These remained out, on the average, until two hours and twenty minutes after sunrise.

Wind appeared to greatly interfere with normal feeding. Cottontails were never observed in the open on windy morning or evenings. Occasionally individuals would be found eating under the shelter of loose brush. This aversion to open situations under such circumstances might be interpreted as a protective type of behavior. The noise and motion produced by wind would greatly handicap those animals which rely largely upon hearing and sight for the detection of natural enemies.

Manner of feeding.—Apparently light intensity is an important factor governing to a considerable extent the distance from shelter that cottontails will venture for food. When in direct sunlight they stay close to brush, seldom going more than six to ten feet out into the open. In shaded situations, however, they were observed to travel as much as seventy or eighty yards along the outer margins of brushy tracts to find suitable feeding grounds. In the evening as darkness approaches they seem to be less afraid to venture into the open. At dusk, on occasions, individuals were noted thirty yards from adequate shelter. Cottontails inhabiting burrows in the open were observed traveling as far as eighty yards from their burrows to small depressions or to shrubs which aided in concealing them.

A number of records were made of the greatest distance out into the open away from burrows or brush that these animals traveled after dark. These ranged up to 110 yards. Cottontails invariably were found farther out in the open at dawn than at dusk. In the morning, even after it was quite light, individuals were frequently noted between fifty and sixty yards away from shelter. As the light increased, noticeable changes in behavior were apparent. Feeding was gradually carried on closer to brush until, after a certain time, very few individuals were seen.

When eating low vegetation, such as grass, in open situations a number of successive mouthfuls are taken. Following this the head is elevated and chewing ensues. Any unusual noise will cause chewing to cease immediately. The terminal portions of these plants are chosen as a general rule. This was always seen to be the case along trails where grass was growing to any considerable height. Rabbits while feeding on low-growing or previously grazed grass, give the impression of drawing the body along the ground. The neck is gradually stretched out and the front feet are edged forward so as to facilitate the reaching of more distant food material. When it is no

longer possible to stretch any farther the hind feet are brought forward with a small hop and the process is repeated. Thus, if undisturbed, feeding rabbits often travel only five or six feet over a period of one-half an hour.

When edible brush, such as wild rose, is present much of the late morning feeding takes place within the shelter of this dense vegetation. Rabbits were frequently observed standing on their hind feet, with the fore limbs hanging down and the body held at a slight angle forward, eating the higher branches of these plants. All stems bitten off by cottontails as well as other species of rabbits are cut at an angle of approximately forty-five degrees. These cuts are always clean and characteristic.

Food plants and seasonal variation with respect to food eaten.—Audubon cottontails, like most other members of the rabbit family, appear to be capable of subsisting upon a large variety of different plants present in any one locality. The following is a list of plants upon which these rabbits were observed feeding in northern Stanislaus and southern San Joaquin counties, between the summer of 1930 and the summer of 1931: various grasses (unidentified as to genera and species) of the Fescue tribe, foxtail grass (*Hordeum murinum*), galingale (*Cyperus* spp.), sedge (*Carex* spp.), rush (*Juncus* spp.), willow (*Salix* spp.), valley oak (*Quercus lobata*), miner's lettuce (*Montia perfoliata*), blackberry (*Rubus vitifolius*), California wild rose (*Rosa californica*), common hoarhound (*Marrubium vulgare*), *Baccharis douglasii* and California mugwort (*Artemisia vulgaris* var. *heterophylla*).

Those animals which lived out in open fields depended almost entirely upon grass for food. However, individuals inhabiting brush showed considerable variation as regards food plants selected, both with the times of day at which feeding took place and with the seasons of the year. Grass was consumed mostly in the early morning and late evening, whereas late morning and early evening feeding was largely upon shrubby plants which either provided or were close to shelter.

During the summer months dry grass, supplemented to some extent by sedge, wild rose, *Artemisia* and *Baccharis*, constituted the principal species of plants used for food. Next to the grass, wild rose was consumed in greatest quantity. In many places the entire daylight periods of feeding were spent in loose rose thickets. The more

slender stems, measuring up to one-fifth of an inch in diameter, were usually chosen. The leaves were sometimes eaten, at other times they were pulled off before the stem was bitten. By December the rose-bushes had shed their leaves and ceased to be reckoned with as a food item.

In the fall the list of food plants became greater, due probably to the increasing scarcity of vegetation in general. Dry grass, sedge, rush, willow, blackberry, hoarhound, *Baccharis* and *Artemisia* were all eaten when food was least abundant. In the late fall a rather heavy attack was made upon hoarhound, where it grew in rabbit-inhabited areas. All these plants were trimmed quite low. Apparently the bitterness of this species did not act as a deterrent. It was seldom, however, that very much was eaten at one time. As a rule several bites would be taken, then the feeding individual would eat the surrounding grass for a few minutes, after which time several more bites would be taken.

In certain localities a transition type of vegetation was found to occur between the open meadow and the brush association. Willow and California mugwort were often seen growing sparingly in such areas. Occasionally rabbits were found feeding on these plants. The smaller willow shoots were bitten off in the same manner as wild rose twigs.

In early winter, before the green grass appeared, considerable sedge, rush, blackberry and *Baccharis* was eaten. During December the change in menu from dry to green grass was very gradual. As the green blades became taller and more abundantly interspersed among the dry stems both were eaten together. Careful observations, made with field glasses upon feeding rabbits, during this month failed to reveal any discrimination made regarding the selection of either type of grass. Mouthfuls of both the dry and the green were taken. By the middle of January green grass was very abundant and constituted the chief article of food for cottontails until late spring. A small amount of sedge, miner's lettuce and mugwort was also consumed during the spring months.

The effect of rabbit grazing on grass is sometimes very striking (fig. 21). In northern Stanislaus County observations were carried on for over one year, both on a patch of brush which harbored a number of cottontails and on adjacent grasslands where they fed. When this study was first started in the fall of the year it was noted

that grass was absent close to the brush. This was attributed to the fact that the rabbits inhabiting this cover had grazed it off. However, in late winter and spring when green grass was coming up abundantly elsewhere there was a strip of land averaging approximately twelve feet wide, adjacent to the brush, which was almost entirely devoid of any vegetation. Apparently the attack by rabbits on the grass near the brush was so great that reproduction on the part of



Fig. 21—Showing the effect of cottontail feeding on vegetation close to brush. Note the entire absence of dry grass immediately adjacent to a wild rose thicket in northern Stanislaus County, California. Photograph taken November 11, 1931.

those species which grew thereabouts was almost entirely prevented as also was reinvasion from distant areas.

In two separate localities within this general region where observations were made upon members of this species alfalfa fields were situated adjacent to uncultivated pastures. Cottontails which inhabited areas from which both types of feeding grounds were readily accessible showed a constant preference for the alfalfa fields. The margins of these fields were quite obviously grazed by the rabbits.

During the latter part of September, 1933, in moist situations along the east side of the Sacramento River in Butte County, California, cottontails were observed in small clearings feeding upon creeping eragrostis (*Eragrostis hypnoides*) and spike rush (*Eleocharis palustris*). These two plants also formed an important part of the food of jack rabbits which frequently fed in the same clearings with cottontails.

On December 27, 1932, the writer was told by a farmer, located a short ways southeast of Priest Valley, in Fresno County, California, that each year he lost a strip of barley approximately eight feet wide and about one-quarter of a mile long, due to cottontails and brush rabbits. This could readily be understood as the margin of the field along which the loss occurred was immediately adjacent to brushland which was well inhabited by members of both species.

In view of the limited distance that these rabbits will traverse in the open it is probable that had the brush been cleared back to a distance of fifty or sixty yards from the planted grain no appreciable loss would have occurred as a result of rabbit feeding.

REPRODUCTION

Breeding season.—The breeding season of the Audubon cottontail in California extends from December to June. Pregnant females have been taken during all these months, exclusive of January.

Seven adult cottontails collected on February 7, 1933, near Buttonwillow, Kern County, by Dr. E. Raymond Hall, Mr. Donald McLean and Mr. Ward C. Russell, gave indication that the breeding season in this locality had already begun. Four of these were males with large testes measuring from 50 to 65 millimeters in length, and three were females, two of which were pregnant.

The peak of the breeding season, as shown by the greatest number of pregnant females, occurs during the month of April. Young one-fourth to one-third grown have been taken during every month from March to August.

Rate of reproduction.—Sufficient data are lacking to definitely state the number of litters born annually, but considering the length of the breeding season it is not improbable that in many instances this number may exceed two. The average number of young per litter, based on records of nineteen pregnant females, is 3.6 with extremes of 2 and 6. It is evident from these figures that the average number of young per litter for this species is but little over half that of the Nuttall cottontail. This disadvantage is perhaps offset by the greater extent of the breeding period (December to June as compared with April to July for *Sylvilagus nuttalli*). This appears significant in that it indicates a greater number of young produced at one time by species (possibly also subspecies within a single species) living in regions where environmental conditions are such as to neces-

sarily limit the length of that period of the year in which reproduction takes place. The Nuttall cottontail inhabits the Great Basin region which is characterized by cold winters and hot, dry summers. The Audubon cottontail on the contrary inhabits areas, at least in California, which are lacking in such extreme seasonal climatic changes.

All specimens examined, taken during the late fall and early winter, are in full adult pelage indicating that maturity is probably attained in less than one year.

Nests and young.—Practically nothing was ascertained regarding this phase in the life history of the Audubon cottontail. It seems highly probable that nests are constructed for the young of this species as is true in the case of the Nuttall cottontail and brush rabbit. It is also likely that in certain instances these nests are inside of burrows rather than on the surface of the ground. Mr. Joseph Dixon (MS), on May 29, 1918, west of Fresno, California, saw three very young, half-drowned cottontails float out of a burrow whose entrance was situated in a newly made irrigation ditch which was being filled with water for the first time. Apparently these young had been born in this burrow as they were too young to move about to any extent by themselves. Their weights, in grams, were 46.3, 50.0 and 56.2, respectively. The pelage on these three animals, which were preserved as study skins, is very short, being but little over three-sixteenths of an inch in length and closely adpressed to the body.

Observations by Dice (1929, p. 227; 1933, p. 162) on captive eastern cottontails (*Sylvilagus floridanus alacer*) have shown that the young of this species are born with the eyes shut and with "a close growth of stiff hair over the whole body." This hair is about five millimeters in length. He gives the period of gestation as twenty-eight days or less and states (p. 228) that "the young in this subspecies are weaned at about four weeks of age."

NATURAL ENEMIES

Mammals.—Coyotes (*Canis latrans*), bobcats (*Lynx rufus*) gray foxes (*Urocyon cinereoargenteus*) and kit foxes (*Vulpes macrotis*) are undoubtedly extremely important factors limiting the numbers of cottontails throughout much of the range of this species. In San Joaquin County, on three separate occasions, the writer observed stray house cats stalking cottontails.

Birds.—Probably many of the larger hawks and owls prey upon cottontails to a certain extent. Remains of cottontails (*Sylvilagus auduboni sanctidiegi*) are mentioned as being found twice in the nest of a pair of golden eagles by F. L. Sumner, Jr. (1929, p. 96). Bryant (1918, p. 127) records the remains of *Sylvilagus a. sanctidiegi* found in the stomach of a male marsh hawk (*Circus hudsonius*) taken at Torrance, Los Angeles County, California. Swarth (1929, p. 295) found "the remains of a small cottontail rabbit" in the nest of a Swainson hawk (*Buteo swainsoni*) on the Santa Rita Range Reserve in southern Arizona.

On September 14, 1930, the stomach and bits of fur of a cottontail were found under a valley oak in San Joaquin County, where a great horned owl (*Bubo virginianus*) could very often be seen in the evening. Only a few fragments of owl pellets were present, but bits of fur on the brush beneath seemed to clearly indicate the predator. During February, 1931, rabbit fur was frequently found under this same tree.

An examination of barn owl (*Tyto alba*) pellets, collected on February 22, 1931, in southern San Joaquin County, along the east bank of the San Joaquin River, revealed the skull of a young cottontail about one-fourth grown and a portion of the lower jaw of an adult of this species. Grinnell, Dixon and Linsdale (1930, p. 233) mention finding remains of a young cottontail in barn owl pellets taken along the Sacramento River in Tehama County.

Reptiles.—F. L. Sumner, Jr. (1931, p. 273) cites an instance in which a gopher snake (*Pituophis catenifer*) was seen to kill a full-grown cottontail in its burrow and proceed to eat it. Rattlesnakes (*Crotalus confluentus*) are also undoubtedly important enemies of this species.

Sylvilagus bachmani* (Waterhouse)*BRUSH RABBIT**

Plates 8, 9; Plate 10, figures 1-4

Specific diagnosis.—Size, medium, with total length of adults varying from 300 to 375 mm.; hind legs rather short; hind feet slender and not covered with a long, dense type of pelage; ears of medium length, somewhat pointed and sparsely haired on their inner, concave surfaces; vibrissæ composed mostly of black hairs, although some of those situated more ventrally possess white tips; adults undergoing but one annual molt; tail small, grizzled above and white beneath; rostrum relatively short; supra-orbital processes small, with the tips of the antorbital projections rather blunt; postorbital extensions of supraorbital processes varying from slender to moderately broad; jugals relatively slender; brain-case slender; the absence, presence or degree of constriction of posterior part of anterior palatine foramina varying geographically; palatal bridge of medium length; posterior margin of palatal shelf may or may not possess a median spine; auditory bullæ varying from small to large; molariform teeth relatively small; anterior surface of first upper molariform tooth possessing three re-entrant angles; posterior halves of second to fourth lower molariform teeth possessing lateral diameters which are equal to about four-fifths the lateral diameters of the anterior halves; ridge of enamel separating the individual molariform teeth into anterior and posterior sections showing but slight indication of crenulation.

***Sylvilagus bachmani bachmani* (Waterhouse)**

Plate 9, figures 5, 6

Lepus bachmani WATERHOUSE (1838, p. 103), original description.

BACHMAN (1839, p. 96).

Lepus trowbridgei BAIRD (1855, p. 333), part.

Lepus trowbridgei, ALLEN (1875, p. 434), part.

Lepus bachmani, THOMAS (1898, p. 320).

Lepus floridanus bachmani, ELLIOT (1901, p. 281), part.

Sylvilagus (Microlagus) bachmani [bachmani], LYON (1904, p. 336).

Sylvilagus bachmani bachmani, NELSON (1909, p. 247), part; DICK (1926, p. 21); GRINNFIL, DIXON and LINSDALE (1930, p. 551), part.

Type.—Adult, skin and skull; No. 53.8.29.36, British Museum; probably taken between Monterey and Santa Barbara (San Luis Obispo typical), California (see Nelson, 1909, p. 248); collected by David Douglas.

Geographic distribution.—From the vicinity of Monterey, Monterey County, south along the coast to northern Santa Barbara County (fig. 22). Zonal range, Upper Sonoran and Transition. Altitude,

tudinal range, from sea level to probably over 3000 feet in the Santa Lucia Mountains.

Diagnosis.—Size, medium; color, only slightly paler than that of *S. b. macrorhinus*; tips of ventral hairs usually lacking the pure

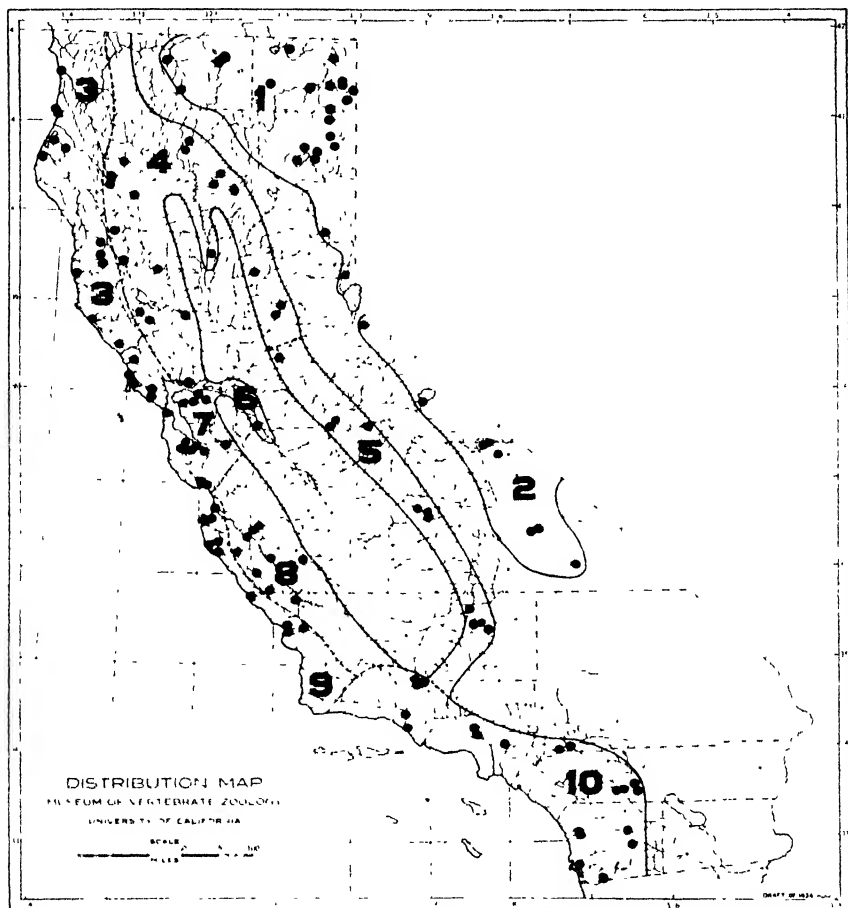


Fig. 22 - Range of the Nuttall cottontail (*Sylvilagus nuttalli*) and brush rabbit (*Sylvilagus bachmani*) in California. 1, *Sylvilagus n. nuttalli*; 2, *S. n. grangeri*; 3, *Sylvilagus b. ubericolor*; 4, *S. b. tchamae*; 5, *S. b. mariposa*; 6, *S. b. riparius*; 7, *S. b. macrorhinus*; 8, *S. b. vigulti*; 9, *S. b. bachmani*; 10, *S. b. cinerascens*.

white color seen in *vigulti* or *cinerascens*; ears of medium size, skull possessing a relatively great zygomatic breadth, a short, tapering rostrum, slit-like postorbital notches and medium-sized auditory bullæ.

Adult fall pelage.—The following description is based upon what

is considered an average specimen chosen from a series collected at Morio, San Luis Obispo County. Back, top of head and anterior margins of flanks light ochraceous-buff on subterminal bands of overhairs; basal portion slate gray; moderate black wash over back; rump slightly paler than back with terminal band of black somewhat reduced; top of tail similar to rump; underside of tail white, with medium-short hairs; anterior outer parts of ears similar to top of head in color, but very finely grizzled due to shortness of hairs and with greater amount of black pigment present toward tips of ears; anterior rims of ears margined with medium-long white hairs, extending from notch two-thirds of way toward extremity; inner posterior portions of ears buffy; posterior outer parts of ears sparsely covered with whitish hairs; nape between cinnamon and Sayal brown; sides of nose and areas extending from backs of eyes very nearly to bases of ears considerably grayer than top of head; vibrissæ black, although those more ventrally situated often indistinctly tipped with white; sides of body paler than back and lacking much of black wash of latter, but becoming richer in color along ventral margins where terminal portion of hairs are light ochraceous-buff; lower parts of fore legs pinkish-cinnamon, becoming paler on tops of fore feet where indistinct patches of white are present; backs of hind legs, just above heels, slightly paler than fore legs; outer proximal three-fourths of hind feet varying from cinnamon-buff to pinkish-cinnamon; tops of hind feet with narrow, median, longitudinal band of white which becomes broader distally; hairs between toes similar in color to sides of feet; chest similar to lower margins of sides with terminal band of black on guard hairs either absent or so reduced as to be barely visible; ventral pelage slaty gray, basally, with terminal band white, or, as seen on some specimens, slightly tinged with buffy.

Juvenile pelage.—The color of the subterminal band of the overhair varies, geographically, from a tone somewhat brighter than pinkish-buff on northwest coast specimens, representing the race *ubericolor*, to a color slightly paler than pinkish-buff, as seen in individuals representing the races *ungultri* and *maniposæ*. The tops of the fore legs and lower parts of the hind legs vary in color from pinkish-buff in *ungultri* to light pinkish-cinnamon in *ubericolor*. The coloration on the ventral part of the body is quite similar to that of adults.

Postjuvenile pelage.—Similar to adult pelage in coloration except

that the terminal band of black on the overhairs of the dorsal parts is shorter, resulting in a paler mass effect (see *Pelage*, p. 25).

Skull (pl. 9, figs. 5, 6).—Size, relatively small; rostrum of medium length, tapering from a proportionately broad base; zygomata widely expanded; supraorbital processes small with postorbital extensions of processes broad, generally touching skull posteriorly and enclosing slit-like notches; brain-case relatively broad and inflated;

TABLE 4

CRANIAL RELATIONSHIPS EXPRESSED IN PERCENTAGES FOR THE VARIOUS RACES OF *Sylvilagus bachmani* OCCURRING IN CALIFORNIA

	Ratio of zygomatic breadth to basilar length		Ratio of length of nasals to basilar length		Ratio of width of nasals to length of nasals		Ratio of palatal length to basilar length		Ratio of length of molar series to basilar length	
	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀
<i>S. b. bachmani</i>	65.2	64.2	53.9	55.6	45.5	46.8	10.5	10.7	24.5	25.5
<i>S. b. tuberculicolor</i>	64.5	63.8	54.6	55.1	45.7	43.3	11.9	12.0	26.3	26.5
<i>S. b. techamiae</i>	64.2	66.2	53.3	55.5	50.8	48.7	12.2	11.8	24.0	25.3
<i>S. b. mariposae</i>	62.8	65.9	56.0	55.3	54.4	54.6	10.3	10.2	24.6	25.0
<i>S. b. macrorhinus</i>	63.1	63.1	55.5	55.3	43.9	44.3	10.7	10.5	25.2	25.3
<i>S. b. riparius</i>	65.8	63.7	58.5	57.2	46.6	42.9	10.2	9.9	25.5	25.0
<i>S. b. virgultii</i>	62.4	63.1	57.4	56.8	43.9	42.3	9.7	9.8	24.4	24.7
<i>S. b. cinereus</i>	64.2	64.4	54.7	54.1	45.5	45.4	9.0	9.8	24.5	25.7

anterior palatine foramina broad and sometimes constricted posteriorly; palatal bridge short; auditory bullae of medium size, well rounded; incisors narrow; molar series short.

Sylvilagus b. bachmani differs from *S. b. macrorhinus* as follows: smaller, with proportionately greater zygomatic breadth; rostrum shorter, more tapering and relatively broader, basally; brain-case shorter and less depressed dorsally; anterior palatine foramina lacking well-marked posterior constrictions; palatal bridge shorter; auditory bullae larger; molar series shorter. When compared with *virgultii*, *bachmani* is seen to differ in that it possesses a much shorter and broader rostrum, a greater zygomatic breadth and smaller auditory bullae.

Remarks.—A series of brush rabbits from northern Monterey County, near the mouth of the Salinas River, show many characters intermediate between those of the races *bachmani* and *virgultii*. Some skulls indicate a definite approach toward *virgultii* as regards the long rostrum characteristic of that race, while others more nearly

resemble *bachmani* in this respect. On the average, the auditory bullæ of specimens from this locality are smaller as seen in the coastal form. The tone of coloration, while not as dark as is typical of *bachmani*, is nearer it than to the pallid, inner, south-central coast range form. A single individual examined from the Big Sur River, Monterey County, is not distinguishable from specimens from Morro, San Luis Obispo County.

Measurements.—The average and extreme measurements of 4 adult males from southwestern Monterey County and coastal San Luis Obispo County are as follows: Total length, 321.0 (307–337); tail vertebræ, 31.0 (27.0–36.0); hind foot, 70.8 (64–77); basilar length (3 averaged), 47.7 (47.0–48.0); zygomatic breadth (3 averaged), 31.1 (30.4–31.6); postorbital constriction (3 averaged), 10.3 (9.6–10.9); length of nasals (3 averaged), 25.7 (24.8–26.8); width of nasals, 11.7 (11.4–12.1); length of molar series, 11.7 (10.9–12.1); diameter of external auditory meatus, 4.6 (4.2–4.8); breadth of brain-case (3 averaged), 21.4 (20.8–22.1); length of palatal bridge, 5.0 (4.1–4.6). The average and extreme measurements of a series of adult females from the coast of central Monterey and San Luis Obispo counties are as follows: External measurements (5 averaged): Total length, 330 (310–360); tail vertebræ, 27.8 (25–30); hind foot, 73.4 (71–75). Skull measurements (4 averaged, unless otherwise indicated): Basilar length (3 averaged), 47.7 (45.7–48.8); zygomatic breadth (3 averaged), 30.6 (29.7–31.8); postorbital constriction, 10.2 (9.2–10.9); length of nasals, 26.5 (25.3–27.3); width of nasals, 12.4 (11.9–13.0); length of molar series, 12.2 (11.8–12.4); diameter of external auditory meatus, 4.6 (4.4–4.8); breadth of brain-case, 21.3 (20.7–21.6); length of palatal bridge, 5.1 (4.6–5.6).

Weights.—Two adults, a male and a female, from near Morro, San Luis Obispo County, weighed 618 and 622 grams, respectively.

Specimens examined.—A total of 42 from the following localities: Monterey County: 2 miles south of mouth of Salinas River, 6; near Seaside, 14; Monterey (coll. Calif. Acad. Sci.), 4; Salinas Valley (probably near mouth) (coll. Calif. Acad. Sci.), 3; Little Sur River (coll. Calif. Acad. Sci.), 1; one and one-half miles south of Big Pines, 1; Big Sur River, 1. San Luis Obispo County: San Carpojo Creek, 7 miles north of Piedras Blancas, 6; near Morro, 4; Santa Margarita, 2.

***Sylvilagus bachmani ubericolor* (Miller)**

Plate 8, figures 1, 2

Lepus trowbridgii BAIRD (1855, p. 333), part.*Lepus trowbridgei*, ALLEN (1875, p. 434), part.*Lepus sylvaticus auduboni*, TOWNSEND (1887, p. 181), part.*Lepus bachmani ubericolor* MILLER (1899, p. 383), original description.*Lepus floridanus bachmani*, ELIOT (1901, p. 281), part.*Lepus* [*Microlagus*] *bachmani ubericolor*, MILLER and RICH (1901, p. 189).*Lepus floridanus ubericolor*, ELIOT (1903a, p. 192), part.*Sylvilagus* (*Microlagus*) *bachmani ubericolor*, LYON (1904, p. 337).*Sylvilagus bachmani ubericolor*, NELSON (1909, p. 250), part; GRINNELL, DIXON and LINDSAY (1930, p. 552), part.

Type.—Adult male, skin and skull; No. 19964 35371, United States National Museum; from Beaverton, Washington County, Oregon; collected February 25, 1890, by A. W. Anthony; original No. 1226.

Geographic distribution.—Restricted in California to the immediate vicinity of the coast, from the Oregon boundary south to Marin County (fig. 22). Zonal range, mostly humid Transition. Altitudinal range, from sea level to probably over 2000 feet.

Diagnosis.—Size largest and color darkest of any of the races of the *bachmani* group; ears very small; skull characterized as follows: size, very large; rostrum tapering relatively little; postorbital processes short and slender, enclosing well-rounded notches (see fig. 2, B); anterior palatine foramina strongly constricted posteriorly; auditory bullae very small.

Adult fall pelage.—Overhairs of back and top of head cinnamon on subterminal band; basal portion of hairs deep neutral gray; sides somewhat paler than dorsum; hairs on inner posterior parts of ears, near margins, similar in color to sides of body; nape between cinnamon and Sayal brown; lower parts of fore legs and backs of hind legs above heels cinnamon; terminal band of ventral hairs very short in comparison with these hairs in other races, also buffy in color, somewhat as in *bachmani*.

Skull (pl. 8, figs. 1, 2).—Size, large; rostrum long and only slightly tapering; jugals broad, heavy and very nearly parallel; supraorbital processes well developed but with postorbital extensions of processes short and narrow, enclosing rather large oval-shaped notches;

brain-case elongated and depressed; anterior palatine foramina long and very much constricted posteriorly; auditory bullæ actually smaller than those of any other race of *Sylvilagus bachmani*; palatal bridge very long; incisors broad; molar series heavy.

For comparisons see *S. b. tehamæ* and *S. b. macrorhinus*.

Remarks.—The range of *Sylvilagus b. ubericolor* extends over a greater area than that of any other race of this species, a distance of over six hundred miles from extreme northwestern Oregon south to San Francisco Bay, California. Despite this fact, there is no great degree of difference to be noted between specimens from the opposite extremes of the territory occupied. No topotypes were available, but one adult, skin and skull, from Tillamook, Oregon, not far from the type locality, was the most richly colored of any brush rabbits examined. This tendency toward extremely dark coloration in this region is confirmed by Nelson (1909, p. 251) who states as follows: "The type from Beaverton, Oregon, is the most deeply reddish example seen. . . ." Marin and Mendocino county specimens tend to be slightly paler than those from farther north along the coast of California.

When a comparison was made of skulls of *ubericolor* from Humboldt County with those from Marin County, the latter were seen to differ from the former in the following respects: size, averaging slightly smaller; rostrum somewhat more tapering; brain-case slightly broader; auditory bullæ a trifle larger. These differences are so slight as to hardly warrant a nomenclatural separation of the race into two forms. This area just north of San Francisco Bay, even though near the coast, may represent a region of intergradation between *ubericolor* and *tehamæ* at the extreme southern ends of their ranges.

Measurements.—The average and extreme measurements of 7 adult males from Del Norte and Humboldt counties are as follows: Total length, 332.4 (317–345); tail vertebrae (6 averaged), 34.0 (30–38); hind foot, 76.7 (74–80); basilar length, 51.3 (49.0–53.7); zygomatic breadth, 33.1 (31.7–33.9); postorbital constriction, 11.0 (10.5–11.5); length of nasals, 28.0 (26.4–29.7); width of nasals, 12.8 (12.0–13.7); length of molar series, 13.5 (13.1–13.9); diameter of external auditory meatus, 4.3 (4.1–4.5); breadth of brain-case, 22.6 (22.0–23.2); length of palatal bridge, 6.1 (5.8–6.4). The average and extreme measurements of 6 adult females from Del Norte and Hum-

boldt counties are as follows: Total length, 346.0 (335–365); tail vertebræ, 32.2 (26–38); hind foot, 77.0 (75–80); basilar length, 52.4 (50.0–55.4); zygomatic breadth, 33.4 (32.3–34.3); postorbital constriction, 10.9 (9.0–12.5); length of nasals, 28.9 (27.0–32.1); width of nasals, 12.5 (11.5–13.9); length of molar series, 13.9 (13.2–14.3); diameter of external auditory meatus, 4.3 (4.0–4.6); breadth of brain-case, 23.1 (22.8–23.7); length of palatal bridge, 6.3 (5.8–6.6).

Specimens examined.—A total of 63 from the following localities: Del Norte County: Requa (coll. Calif. Acad. Sci.), 5. Humboldt County: Patrick's Point, 1; near Trinidad, 2; Eureka, 13; Fair Oaks, 4; Ferndale, 3. Mendocino County: Laytonville (coll. Calif. Acad. Sci.), 1; Sherwood (coll. Calif. Acad. Sci.), 3; Mendocino City, 3; Gualala, 7. Sonoma County: 7 miles west of Cazadero, 2; Freestone, 2. Marin County: Tomales Point, 1; Point Reyes, 5 miles west of Inverness, 1; 3 miles west of Inverness, 10; Nicasio (coll. Calif. Acad. Sci.), 3; Mailliard, 1; Lagunitas, 1.

***Sylvilagus bachmani tehamæ* Orr**

Plate 8, figures 3, 4

Lepus townsendi, ELLIOT (1898, p. 213).

Lepus bachmani ubercolor, MILLER (1899, p. 383), part.

Sylvilagus bachmani ubercolor, NELSON (1909, p. 250), part.

Sylvilagus bachmani mariposa, GRINNELL and STORER (1916, p. 8), part.

Sylvilagus bachmani bachmani, GRINNELL, DIXON and LINDSAY (1930, p. 552), part; GRINNELL (1933, p. 203), part.

Sylvilagus bachmani tehamæ ORR (1935, p. 27), original description.

Type.—Adult male, skin and skull; No. 34971, Museum of Vertebrate Zoölogy; from Dale's, on Paine's Creek, 600 feet altitude, Tehama County, California; collected December 26, 1924, by J. Grinnell; original No. 6183.

Geographic distribution.—From northern Shasta and Trinity counties (possibly Siskiyou County), south along the inner northern coast ranges to Lake and Yolo counties, and south along the western slopes of the Sierra Nevada to Placer County; south in the Sacramento Valley at least to Butte County (fig. 22). Zonal range, mostly Upper Sonoran and low Transition. Altitudinal range, from 100 to 5500 feet.

Diagnosis.—Size, rather large; color, almost as rich dorsally as seen in *S. b. ubercolor*, but sides paler and tips of ventral hairs lacking a buffy tinge; ears small; skull characterized, as regards the race, by a

short but basally broad rostrum, well-rounded postorbital notches, a long palatal bridge and fairly small auditory bullæ.

Adult fall pelage.—Subterminal bands of dorsal guard hairs pinkish-cinnamon; tips of hairs with conspicuous band of black; inner posterior portions of ears only faintly tinged with buffy as contrasted with *ubericolor*; sides almost as pale as in *mariposæ*; lower parts of fore legs and hind legs above heels between pinkish-cinnamon and cinnamon; terminal portion of ventral hairs white.

Skull (pl. 8, figs. 3, 4).—Size, medium; rostrum short and tapering but very broad at base; zygomata widely expanded; supraorbital processes long and well developed with postorbital extensions of processes small and slender, enclosing oval-shaped notches; brain-case depressed; anterior palatine foramina short and usually possessing a noticeable posterior constriction; palatal bridge long; auditory bullæ small; incisors broad; molar series long.

Compared with *Sylvilagus b. ubericolor*, *tehamæ* is seen to be smaller, with rostrum proportionately much shorter and broader at base, palate relatively longer and auditory bullæ actually larger. This race differs from *mariposæ* in the following respects: size, larger, zygomata more expanded, rostrum broader at base, postorbital notches more rounded, palatal bridge longer and auditory bullæ slightly smaller.

Remarks.—This race undoubtedly shows close relationship to the northwest coast form *ubericolor*, in that it possesses a very long palatal bridge, smaller auditory bullæ and extremely well-rounded postorbital notches. These characters serve to distinguish these two races from all other members of the *bachmani* group. The exceptionally broad base of the rostrum as well as the relatively short nasals possessed by members of the race *tehamæ* are unique among brush rabbits from northern or central California. *Sylvilagus b. mariposæ*, *macrohinus* and *ingulthi* have very slender rostra, while *ubericolor*, although having a rostrum that is moderately broad, does not exhibit any tendency toward abrupt tapering.

In Trinity and Mendocino counties *tehamæ* intergrades with *ubericolor*, specimens examined from both South Fork Mountain in Trinity County and from Mt. Sanhedrin, Mendocino County, being regarded as intermediates approaching closest to the inland race. Skulls of brush rabbits from both of these localities are larger than typical *tehamæ* and possess auditory bullæ that average slightly

smaller. A subadult, in the collection of the Museum of Vertebrate Zoölogy from Covelo, Mendocino County, maintains the characters of the inner coast range race, exhibiting pallid coloration on the sides and lacking any buffy tinge on the underparts. Cranially, it is very nearly identical with the skull of an individual of comparable age from eastern Tehama County, except for the palatal bridge which is longer. One juvenile from Rumsey, Yolo County, while in all probability an intergrade between *tehamæ*, *macrorhinus* and possibly *napaeus*, is tentatively placed with the first mentioned race for lack of more adequate material. A single specimen taken near Stonyford, Colusa County, indicates that brush rabbits in the inner, north central coast ranges possess rather pallid coloration. This individual, while cranially nearest the *tehamæ* type, is strikingly pale on the dorsal surface with the sides of the body a very dark gray.

The area of intergradation along the west slope of the Sierra Nevada appears to be comparatively broad. Three skins and skulls from Auburn, Placer County, in the collection of the United States Bureau of Biological Survey, are definitely referable to *tehamæ*, although in dorsal coloration they in no way approach the brilliant color exhibited by more typical members of this form from farther north. Two adults examined from Rackerby, Yuba County, are paler still on the back, very much resembling *mariposa*. The color of the fore legs is, however, quite bright as seen in *tehamæ*. As regards cranial features these two specimens are intermediate in most characters between *tehamæ* and *mariposa*, although a tendency is shown toward the type of rostrum typical of the more northern race.

Measurements.—The average and extreme measurements of 1 adult males from eastern Tehama County are as follows: Total length, 320.5 (300–340); tail vertebrae, 29.8 (26–33); hind foot, 73.5 (70–78); basilar length, 49.2 (48.2–50.0); zygomatic breadth, 31.6 (30.3–32.7); postorbital constriction, 10.7 (10.2–11.0); length of nasals, 26.2 (25.3–26.9); width of nasals, 13.3 (12.6–14.0); length of molar series, 11.8 (11.5–12.0); diameter of external auditory meatus, 4.0 (3.8–4.3); breadth of brain-case, 21.8 (21.2–22.4); length of palatal bridge, 6.0 (5.5–6.5). The average and extreme measurements of 8 adult females from southern Shasta and Tehama counties are as follows: Total length (7 averaged), 326.4 (305–345); tail vertebrae (7 averaged), 28.0 (22–31); hind foot (7 averaged), 74.6 (70–79); basilar length (7 averaged), 48.1 (47.4–49.4); zygomatic breadth (6 averaged), 31.8 (31.2–

32.3); postorbital constriction, 11.1 (9.8–12.4); length of nasals (7 averaged), 26.7 (25.2–28.0); width of nasals, 13.0 (11.9–14.0); length of molar series, 12.1 (11.7–12.6); diameter of external auditory meatus, 4.1 (3.9–4.3); breadth of brain-case (7 averaged), 21.9 (21.4–22.5); length of palatal bridge, 5.7 (5.3–6.1).

Weights.—The average and extreme weights of 4 adult males from eastern Tehama County are 583.8 (511.0–686.6) grams. The average and extreme weights of 3 adult females from eastern Tehama County are 650.4 (619.0–742.8) grams.

Specimens examined.—A total of 63 from the following localities: Shasta County: McCloud River near Baird Station, 1; Stillwater (coll. U. S. Biol. Surv.), 4. Trinity County: 3 miles west of Knob, Shasta County, 4400 feet altitude (coll. Calif. Acad. Sci.), 3; divide, 12 miles north of Yolla Bolly Mountain, 4400 feet altitude, 1; Hayfork, 1; near Mad River Bridge, South Fork Mountain, 4; The Race-track, South Fork Mountain, 5500 feet altitude, 3; Mad River Ford, above Ruth, 2700 feet altitude, 1; summit of South Fork Mountain, 3 miles northwest of Forest Glen (coll. Calif. Acad. Sci.), 1. Tehama County: Dale's on Paine's Creek, 600 feet altitude, 1; Lyman's, 3300 feet altitude, 4 miles northwest of Lyonsville, 3; Manton, 2300 feet altitude, 9; Mill Creek, 2 miles northeast of Tehama, 2; Tehama (coll. U. S. Biol. Surv.), 1; Tomhead Mine, near Mt. Tomhead, 4000 feet altitude, 1. Yuba County: Rackerby (coll. Calif. Acad. Sci.), 2. Placer County: Auburn (coll. U. S. Biol. Surv.), 3; Applegate (coll. Calif. Acad. Sci.), 1. Mendocino County: Lierly's Ranch, 4 miles south of Mt. Sanhedrin, 2; 3 miles south of Covelo, 3; 6 miles north of Willits, 2. Lake County: Glennbrook (coll. Calif. Acad. Sci.), 1; Castle Springs, 2700 feet altitude (coll. Calif. Acad. Sci.), 1. Yolo County: Rumsey, 1. Colusa County: 3 miles west of Stonylford, 1. Butte County: 14 miles south of 7 miles west of Chico, 100 feet altitude, 7.

***Sylvilagus bachmani mariposæ* Grinnell and Storer**

Plate 8, figures 5, 6

Sylvilagus bachmani bachmani, NIXON (1909, p. 249), part.

Sylvilagus bachmani mariposæ GRINNELL and STORER (1916, p. 7), original description; GRINNELL and STORER (1924, p. 228).

Sylvilagus bachmani virgultus DICE (1926, p. 26), part.

Type.—Adult male, skin and skull; No. 21867, Museum of Vertebrate Zoology; taken in "adenostoma association, on McCauley Trail,

at 4000 feet altitude, near El Portal, Mariposa County, California"; collected on December 7, 1914, by J. Grinnell; original No. 2972.

Geographic distribution.—Along the western slopes of the Sierra Nevada from Eldorado County south to the Piute Mountains in Kern County (fig. 22). Zonal range, Upper Sonoran and low Transition. Altitudinal range, from 600 to 6700 feet.

Diagnosis.—Size, medium; color, pale with sides conspicuously gray; ears of medium length; skull of medium size with slender post orbital processes enclosing slit-like notches, short anterior palatine foramina which are only slightly constricted posteriorly, small molar series and moderately small auditory bullae.

Adult fall pelage.—Upper parts much paler than *tehamae* with subterminal band of overhairs nearest pinkish-buff and basal portion slate gray; conspicuous black wash over back; nape pinkish-cinnamon; sides slightly paler than *tehamae*; lower outer parts of fore legs and backs of hind legs above heels nearest pinkish-cinnamon; white area on tops of hind feet more distinct than seen in *tehamae*; ventral pelage with a relatively long terminal band of white.

Skull (pl. 8, figs. 5, 6).—Size, moderately small; rostrum of medium length, but rather narrow at base; zygomata not widely expanded; postorbital extensions of supraorbital processes slender, touching skull posteriorly and enclosing slit-like notches; brain-case small and narrow, only slightly arched dorsally; anterior palatine foramina short and only slightly constricted posteriorly; palatal bridge short; auditory bullae rather small; molar series light.

When contrasted with *Sylvilagus b. angulatus* the following cranial differences are noted: Size smaller; zygomata broader; rostrum shorter and broader; postorbital extensions of supraorbital processes more slender; anterior palatine foramina shorter; auditory bullae much smaller. For further comparison see *Sylvilagus b. tehamae*.

Remarks.—Along the Sierra Nevada, from the northern to the southern limits of the range of *mariposa*, there is a gradual but definite paling in the color of the subterminal band of the guard hairs. Brush rabbits examined from Kern County are as gray in tone of coloration as members of the race *angulatus* from the inner, south-central coast ranges. However, as regards the skull, specimens from this southern Sierra Nevada region most nearly resemble *mariposa* in most respects although the postorbital processes are somewhat

broader as seen in *virgulti*. For this reason it seems most suitable to consider specimens from this area as within the range of *mariposæ* rather than that of *virgulti* as was done by Dice (1926, p. 26).

The most constant subspecific character, of those studied throughout the range of *mariposæ*, is the size of the auditory bullæ which do not appear appreciably larger in specimens from Kern County than in those from Mariposa County. Four individuals collected in southern Fresno County do, however, possess bullæ slightly larger than was noted in specimens either to the north or south of this locality.

Measurements.—The average and extreme measurements of 4 adult males from Mariposa and Fresno counties are as follows: Total length, 327.8 (313–340); tail vertebræ, 32.0 (25–41); hind foot, 74.3 (73–75); ear from crown, 78.5 (74–80); ear from notch (2 averaged), 66.0 (64–68); basilar length, 48.4 (46.1–49.6); zygomatic breadth, 30.4 (29.8–31.1); postorbital constriction, 10.6 (9.6–11.8); length of nasals, 27.1 (26.4–29.0); width of nasals, 12.3 (11.7–12.8); length of molar series, 12.0 (11.8–12.3); diameter of external auditory meatus, 4.4 (4.2–4.7); breadth of brain-case, 21.2 (20.9–21.7); length of palatal bridge, 5.0 (4.6–5.4). The average and extreme external measurements of 6 adult females from Mariposa, Fresno and northern Tulare counties are as follows: Total length, 325.2 (309–342); tail vertebræ, 34.3 (27–42); hind foot, 76.2 (71–81); ear from crown (3 averaged), 78.7 (78–80); ear from notch (2 averaged), 66.0 (66–66). The average and extreme cranial measurements of 5 adult females from Mariposa, Fresno and northern Tulare counties are as follows: Basilar length, 47.2 (46.3–48.0); zygomatic breadth (1 averaged), 31.1 (30.8–31.7); postorbital constriction, 10.6 (10.2–11.2); length of nasals, 26.1 (24.8–27.0); width of nasals, 11.9 (11.4–12.3); length of molar series, 11.8 (11.6–12.1); diameter of external auditory meatus, 4.3 (4.1–4.5); breadth of brain-case, 21.4 (20.9–21.9); length of palatal bridge (3 averaged), 4.8 (4.6–4.9).

Weights.—The average and extreme weights of 3 adult males from Mariposa and Fresno counties are 587.4 (563–625) grams. The average and extreme weights of 4 adult females from Mariposa and Fresno counties are, 591.1 (534.1–631.5) grams.

Specimens examined.—A total of 25 from the following localities: Amador County: Carbondale (coll. U. S. Biol. Surv.), 4. Mariposa County: El Portal, 2; Varain, 2; vicinity of Coulterville, 5. Fresno

County: Dunlap, 1; near Miramonte, 3. Tulare County: Badger (coll. U. S. Biol. Surv.), 2. Kern County: Bodfish, 1; Thompson Canyon, 3900 feet altitude, Walker Basin, 1; Kelso Valley, 4400-4500 feet altitude, 3; French Gulch, 6700 feet altitude, Piute Mountains, 1.

***Sylvilagus bachmani riparius* Orr**

Plate 9, figures 1, 2

Sylvilagus bachmani riparius ORR (1935, p. 29), original description.

Type.—Adult female, skin and skull; No. 57348, Museum of Vertebrate Zoölogy; from two miles northeast of Vernalis, in Stanislaus County, California; collected November 11, 1931, by Robert T. Orr; original No. 448.

Geographic distribution.—Known by specimens and observation only from the west side of the San Joaquin River in extreme southern San Joaquin and northern Stanislaus counties. It seems probable that this form inhabits the river bottom area, at least on the western side of the San Joaquin River, north to the delta region and likewise some distance to the southward of where specimens have been obtained (fig. 22). Zonal range, probably Lower and Upper Sonoran.

Diagnosis.—Size, medium; color, rather pallid, being only slightly darker than that of *Sylvilagus b. virgulti*; skull of medium size, possessing rather broadly expanded zygomata and unique in that the sides of the rostrum, when viewed from above, are noticeably convex instead of being straight or even concave as in other races of *bachmani*.

Adult fall pelage.—*Sylvilagus b. riparius*, although a rather pallid form, does not quite reach the extreme grayish color seen in *virgulti*. Subterminal band of guard hairs slightly brighter than pinkish-buff on back and top of head; nape nearest cinnamon-buff; hairs on inner parts of ears entirely grayish-white; anterior parts of fore legs somewhat brighter than seen in *virgulti*; tops of hind feet white, except along outer margins which are slightly buffy; tips of ventral hairs white.

Skull (pl. 9, figs. 1, 2).—Size, medium; rostrum of medium length and, when viewed dorsally, seen to bulge laterally due to convexity of lateral margins of nasals and premaxillaries; nasals only slightly constricted anteriorly; zygomata widely expanded; supraorbital processes well developed with postorbital extensions slender and en-

closing slit-like notches; anterior palatine foramina almost entirely lacking posterior constriction; palatal bridge of medium length; auditory bullæ medium-sized; incisors relatively narrow; molar series of medium length.

Skulls of *Sylvilagus b. riparius* differ from those of *tehamæ* in the following respects: nasals longer; rostrum not as broad at base, and with sides convex; anterior palatine foramina lacking noticeable posterior constriction; palatal bridge much shorter; postorbital extensions of supraorbital processes enclosing slit-like rather than oval-shaped notches; auditory bullæ larger. For further comparisons see *S. b. macrorhinus*.

Remarks.—*Sylvilagus b. riparius* is seemingly a race that is isolated on three sides from other members of the species. It appears likely that the range of this form is continuous along the west side of the San Joaquin River north to the delta region where it probably merges into the darker *macrorhinus* of the coast.

Measurements.—The external measurements of 2 adult males from the type locality are as follows: Total length, 307–317; tail vertebræ, 36–38; hind foot, 78–70; ear from crown, 73–64. The cranial measurements of 1 adult male from the type locality are as follows: Basilar length, 47.9; zygomatic breadth, 31.5; postorbital constriction, 9.1; length of nasals, 27.0; width of nasals, 12.6; length of molar series, 12.2; diameter of external auditory meatus, 4.8; breadth of brain-case, 21.7; length of palatal bridge, 4.9. The average and extreme measurements of 3 adult females from the type locality are as follows: Total length, 335.0 (328–347); tail vertebræ, 39.7 (37–41); hind foot, 76.0 (75–77); ear from crown, 68.3 (68–69); ear from notch (2 specimens), 77–81; basilar length (2 specimens), 48.6–50.0; zygomatic breadth (2 specimens), 31.3–31.5; postorbital constriction, 10.1 (10.0–10.2); length of nasals, 28.2 (27.4–29.3); width of nasals, 12.1 (12.0–12.2); length of molar series, 12.3 (12.2–12.4); diameter of external auditory meatus (2 specimens), 5.0–5.2; breadth of brain-case (2 specimens), 21.3–22.3; length of palatal bridge, 4.9 (4.6–5.1).

Specimens examined.—A total of 5 from the west side of the San Joaquin River in northern Stanislaus County, near Vernalis, San Joaquin County.

***Sylvilagus bachmani macrorhinus* Orr**

Plate 9, figures 3, 4

Lepus townsendi BAIRD (1855, p. 333), part.*Lepus townsendi*, ALLEN (1875, p. 434), part.*Sylvilagus bachmani ubericolor*, NELSON (1909, p. 250), part.*Sylvilagus bachmani bachmani*, GRINNELL, DIXON and LINSDALE (1930, p. 552), part.*Sylvilagus bachmani macrorhinus* ORR (1935 p. 28) original description.

Type.—Adult female, skin and skull; No. 51679, Museum of Vertebrate Zoölogy; from Alpine Creek Ranch, three and one-half miles south of two and one-third miles east of Portola, 1700 feet altitude, San Mateo County, California; collected April 18, 1932, by F. Lowell Sumner, Jr.; original No. 138.

Geographic distribution.—West-central California from San Francisco south along the coast to and including Santa Cruz County; inland from southwestern Solano County south to Santa Clara County (fig. 22). Zonal range, Upper Sonoran and Transition. Altitudinal range, from sea level to nearly 4000 feet.

Diagnosis.—Size, large, being only slightly smaller than *ubericolor*, but with longer ears than those possessed by that race; color slightly darker than that of *bachmani*; skull possessing a long, narrow rostrum, slit-like postorbital notches, anterior palatine foramina which are only moderately constricted posteriorly and small auditory bullæ which, however, are larger than those possessed by *ubericolor*.

Adult fall pelage.—Quite similar to *bachmani*, differing from that race chiefly in the following respects: subterminal band of guard hairs of back and top of head between light ochraceous-buff and ochraceous-buff; lower parts of fore legs and hind legs above heels between cinnamon-buff and Sayal brown; inner posterior part of ears less buffy and more grayish; tips of ventral pelage rarely other than white.

Skull (pl. 9, figs. 3, 4).—Size, large; rostrum very long and tapering from a narrow base; zygomatic not widely expanded; supraorbital processes well developed with postorbital extensions long and moderately slender; anterior palatine foramina long, with posterior constriction usually slight when present; palatal bridge of medium length; auditory bullæ of medium size; molar series of medium size.

Sylvilagus b. macrorhinus is seen to differ cranially from *ubericolor* in the following respects: size slightly smaller; zygomatic

breadth proportionately narrower; rostrum narrower and more tapering, distally; palatal bridge much shorter; postorbital notches slit-like rather than oval-shaped; auditory bullæ definitely larger. When compared with *S. b. riparius*, skulls of *macrorhinus* are seen to differ most noticeably as regards the shape of the rostrum which is long and narrow with the sides nearly straight rather than convex. Likewise, *macrorhinus* is larger and possesses smaller auditory bullæ.

Remarks.—A critical comparison of a large series of brush rabbits representative of this race from just south of San Francisco Bay with a fairly adequate series of the race *ubericolor* from Marin County, just north of the Bay, failed to show any evidence of intergradation between these two subspecies with respect to several characters studied. In all adult specimens of *macrorhinus* examined the auditory bullæ were seen to be larger than the largest bullæ of representatives of *ubericolor*. Similarly, the postorbital notch of *macrorhinus* is always slit-like instead of being oval as is the case in all adult specimens of *ubericolor* examined. The color of *macrorhinus* is noticeably paler than that of *ubericolor*. These two forms do, however, show a close relationship in respect to size, *macrorhinus* being only slightly smaller than *ubericolor* which is the largest race of the species.

Two specimens examined from ten miles southwest of Suisun, Solano County, are somewhat doubtfully placed with this race considering that they are from north of San Francisco Bay, although from quite far inland. In coloration these two individuals are as pale as *riparius* of the San Joaquin Valley. The skulls show but slight tendency toward the type of rostrum characteristic of *riparius*, the nasals being long and slender more as in *macrorhinus*. Likewise, the body length and the small ears correspond closely with those of the coastal form.

A slight tendency toward a more reddish coloration is exhibited by specimens from Santa Cruz County.

Measurements.—The average and extreme measurements of 18 adult males from the type locality are as follows: Total length, 312.2 (319–361); tail vertebrae (17 averaged), 38.5 (31–43); hind foot, 73.5 (70–81); ear from crown (16 averaged), 72.6 (70–81); ear from notch, 62.7 (60–67); basilar length, 50.4 (48.1–53.2); zygomatic breadth (17 averaged), 31.8 (31.0–33.2); postorbital constriction, 10.2 (9.0–11.6); length of nasals, 28.0 (25.5–30.0); width of nasals, 12.3 (11.0–13.6);

length of molar series, 12.7 (12.1–13.6); diameter of external auditory meatus, 5.2 (4.7–5.8); breadth of brain-case, 21.7 (20.5–22.7); length of palatal bridge, 5.4 (4.9–6.3). The average and extreme measurements of 26 adult females from the type locality are as follows: Total length, 351.5 (332–375); tail vertebræ (24 averaged), 39.7 (25–52); hind foot, 74.3 (70–77); ear from crown (21 averaged), 72.9 (66–78); ear from notch, 61.8 (57–66); basilar length, 50.6 (48.1–52.1); zygomatic breadth, 32.0 (30.1–33.3); postorbital constriction, 10.7 (9.9–12.0); length of nasals, 28.0 (26.2–29.7); width of nasals, 12.4 (11.1–13.6); length of molar series, 12.8 (12.1–13.4); diameter of external auditory meatus, 5.3 (4.7–6.0); breadth of brain-case, 21.0 (20.8–23.5); length of palatal bridge, 5.3 (5.0–5.9).

Weights.—The average and extreme weights of 16 adult males from the type locality are 679.3 (560.8–831.5) grams. The average and extreme weights of 22 adult females from the type locality are 707.0 (517.4–843.4) grams.

Specimens examined.—A total of 114 from the following localities: Solano County: 10 miles southwest of Suisun (collection Ralph Ellis), 2; Contra Costa County: west side of Mt. Diablo, 5; near Pacheco, on Walnut Creek, 1; 2 miles southwest of Walnut Creek, 2; Foster's Ranch, Moraga Valley, 2 miles northeast of Moraga, 1. Alameda County: near Berkeley, 23; Oakland, 1. San Francisco County: San Francisco (coll. Calif. Acad. Sci.), 3. San Mateo County: Menlo Park, 7; Alpine Creek, 1700 feet altitude, 18; Skyline Boulevard, near Crystal Spring Lakes, 1; Portola (coll. Calif. Acad. Sci.), 2. Santa Clara County: Palo Alto (coll. Calif. Acad. Sci.), 1; Black Mountain (3 in coll. Calif. Acad. Sci.), 7; San Jose, 1; Stevens Creek, 3; Agnew, 1. Santa Cruz County: Summit Station, Santa Cruz Mountains (coll. Calif. Acad. Sci.), 1; near Santa Cruz, 4.

***Sylvilagus bachmani virgulti* Dice**

Plate 10, figures 1, 2

Lepus cinerascens ALLEN (1890, p. 159), part.

Sylvilagus bachmani cinerascens, NELSON (1909, p. 252), part.

Sylvilagus bachmani virgulti DICE (1926, p. 24), original description.

Type.—Adult male, skin and skeleton; No. 54562, Museum of Zoölogy, University of Michigan; from Soledad, Monterey County, California; collected September 1, 1922, by Lee R. Dice; original No. 1200.

Geographic distribution.—South in the Salinas Valley from central Monterey County to San Luis Obispo County, occurring also on the adjacent ranges to the west and on the Gabilan and Mount Diablo ranges to the east as far south as the Templa Mountains (fig. 22). Zonal range, mostly Upper Sonoran, but extending down to Lower Sonoran in localities. Altitudinal range, as known from specimens collected, from 182 to 1850 feet, although probably extending considerably higher in the Mount Diablo Range according to statements made by residents.

Diagnosis.—Size, medium; color resembling *Sylvilagus b. howelli* of northern Lower California, but even paler; skull long and narrow, with rostrum proportionately slender and auditory bullæ quite inflated.

Adult fall pelage.—Somewhat resembling *riparius*, but with subterminal band of overhairs of back and top of head pale pinkish buff; sides paler and hairs of anterior outer portions of ears containing less black pigment; tops of hind feet conspicuously white; terminal band of ventral hairs white in contrast to the buffy color seen in *bachmani* and *macrorhinus*.

Skull (pl. 10, figs. 1, 2).—Size, medium; rostrum very long; nasals somewhat constricted anteriorly so that lateral margins are nearly parallel to each other for some distance; zygomatic breadth relatively small; supraorbital processes moderately well developed with postorbital extensions slender, often touching skull posteriorly and enclosing slit-like notches; brain-case narrow but not depressed; anterior palatine foramina slender and with only a slight posterior constriction; palatal bridge of medium length; auditory bullæ large and well inflated; incisors narrow; molar series short.

Compared with *Sylvilagus b. riparius* the following differences are noted: skull of *vingulti* approximately similar in size but zygomatic breadth much less; rostrum narrower; nasals constricted along anterior three-fourths making lateral outlines of rostrum more concave and slightly constricted posteriorly; molar series shorter and incisors narrower. When contrasted with *S. b. macrorhinus*, *vingulti* is seen to differ most noticeably from this race by its smaller size and very much larger auditory bullæ.

Remarks.—Although *Sylvilagus b. vingulti*, as noted by Dice (1926, p. 25), represents the palest race of the *bachmani* group in California, it is only slightly lighter than *cinerascens* of the San Jacinto and

other southern mountain ranges. Size and cranial characters, however, serve well to further distinguish it from that form.

Specimens from Soledad, Monterey County, near the type locality, show a tendency toward *bachmani* only in their slightly darker coloration. Two individuals taken in winter pelage from extreme southwestern Fresno County are the most pallid of any specimens of this race examined. Those from the Salinas Valley side of the Mt. Diablo Range, near San Lucas, Monterey County, are slightly darker than brush rabbits from Fresno County, but nevertheless, are considerably paler than those from Soledad. No differences were seen, as regards skulls, between specimens from these three localities. One immature individual from the Pinnacles, San Benito County, represented by a complete skeleton, is tentatively referred to this subspecies. Specimens from Jolon and Bryson, Monterey County, indicate intergradation with *bachmani* as shown by their less pallid tones of coloration and smaller auditory bullæ when compared with typical examples of *virgulti*. Likewise, a specimen from San Miguel, San Luis Obispo County, is in most respects intermediate between these two forms, approaching nearer to *bachmani* in color, although cranially more like *virgulti* as regards the long, slender rostrum and the narrow zygomatic breadth so characteristic of members of the latter race. No skins or skulls were examined from the Temploa Mountains, from which Nelson records brush rabbits under the name *cinerascens*, but in view of the fact that they are merely a southern extension of the Mt. Diablo Range, I should not hesitate to consider *virgulti* as at least extending some distance south along this range.

Measurements.—The average and extreme measurements of 4 adult males from central Monterey and southwestern Fresno counties are as follows: Total length, 317.5 (304–343); tail vertebræ, 32.8 (29–40); hind foot, 73.5 (70–78); basilar length (3 averaged), 48.4 (48.2–48.7); zygomatic breadth (3 averaged), 30.2 (29.4–30.7); post-orbital constriction, 10.5 (9.4–11.9); length of nasals, 27.8 (26.8–28.6); width of nasals, 12.2 (11.7–13.3); length of molar series, 11.8 (11.4–12.1); diameter of external auditory meatus, 4.9 (4.6–5.1); breadth of brain-case (3 averaged), 21.3 (21.0–21.6); length of palatal bridge, 4.7 (4.4–5.3). The average and extreme measurements of 4 adult females from central Monterey and southwestern Fresno counties are as follows: Total length, 319.5 (307–330); tail vertebræ, 34.5

(25-43); hind foot, 73.0 (70-78); ear from crown (2 averaged), 81.0 (78-84); basilar length (3 averaged), 48.2 (46.5-49.3); zygomatic breadth, 30.4 (30.3-30.4); postorbital constriction, 10.2 (9.6-11.1); length of nasals, 27.4 (26.1-28.0); width of nasals, 11.6 (10.3-12.5); length of molar series, 11.9 (11.7-12.2); diameter of external auditory meatus (3 averaged), 5.0 (4.8-5.2); breadth of brain-case (2 averaged), 22.0 (21.8-22.2); length of palatal bridge, 4.7 (4.4-5.1).

Weights.—The average and extreme weights of 4 adult males from central Monterey and southwestern Fresno counties are 593.8 (557.3-685.2) grams. The average and extreme weights of 3 adult females from central Monterey and southwestern Fresno counties are 671.7 (643.8-701.2) grams.

Specimens examined.—A total of 15 from the following localities: San Benito County: the Pinnacles, 1. Monterey County: Stonewall Creek, 1300 feet altitude, 6 $\frac{3}{10}$ miles northeast of Soledad, 1; 1 $\frac{1}{4}$ miles south of Soledad, 182 feet altitude, 2; near San Lucas, 5; Jolon, 1; Bryson (coll. Calif. Acad. Sci.), 1. Fresno County: Waltham Creek, 4 $\frac{1}{2}$ miles southeast of Priest Valley, 1850 feet altitude, 2. San Luis Obispo County: 2 miles south of San Miguel, 1.

***Sylvilagus bachmani cinerascens* (Allen)**

Plate 10, figures 3, 4

Lepus townbridgei, COUPE and ALLEN (1877, p. 315), part.

Lepus cinerascens ALLEN (1890, p. 159), original description.

Lepus (Microlagus) cinerascens, TROUSSART (1897, p. 660).

Sylvilagus (Microlagus) cinerascens, LYON (1904, p. 337).

Sylvilagus bachmani cinerascens, NELSON (1909, p. 252); HUEY (1927, p. 68).

Sylvaticus bachmani cinerascens, STEPHENS (1921, p. 19).

Sylvilagus bachmani exiguus, DICE (1926, p. 26), part.

Type.—Female (adult?), skin and skull; No. 2883/2302, American Museum of Natural History; from San Fernando, Los Angeles County, California; collected March 22, 1890, by E. C. Thuber.

Geographic distribution.—From Ventura County, south along the coast to Lower California, extending inland at the northern limits to the San Emigdio Range, Kern County (fig. 22). Zonal range, Upper Sonoran, for the most part, but extending into Transition locally. Altitudinal range, from sea level on the coast to 5500 feet on Mt. Pinos, Ventura County.

Diagnosis.—Size, small; ears long; pelage slightly paler than seen in *Sylvilagus b. bachmani*, lacking some of the ochraceous tinge possessed by that race; skull of small size, marked by large auditory bullæ.

Adult fall pelage.—Along the coastal parts of San Diego County this form is very similar to *Sylvilagus b. bachmani*, differing from the latter mainly in that the subterminal bands of the overhairs on the back and top of the head are about midway between light ochraceous-buff and light pinkish-cinnamon; terminal portion of ventral hairs white. For color variation throughout the range see "*Remarks*."

Skull (pl. 10, figs. 3, 4).—Size, small; rostrum of medium length, tapering gradually; zygomata only moderately expanded; supraorbital processes small with postorbital extensions broad, well developed and usually touching skull posteriorly, thus enclosing slit-like notches; brain-case somewhat elevated but elongate; anterior palatine foramina short, rather broad posteriorly in proportion to length, and with posterior constriction usually absent; palatal bridge short; auditory bullæ large; incisors narrow; molar series moderately long, relative to length of skull.

When compared with *bachmani* the following cranial differences are seen: size smaller; zygomata not as broadly expanded; postorbital extensions of supraorbital processes generally broader and longer; rostrum relatively longer and narrower basally; brain-case more elongated; auditory bullæ larger. When contrasted with *virgulti*, skulls of *cinerascens* are seen to be smaller with a relatively greater zygomatic breadth, possess much broader postorbital processes and have anterior palatine foramina which are shorter and proportionately broader posteriorly.

Remarks.—Specimens from northern Ventura and southwestern Kern counties indicate intergradation with *virgulti* as is shown by their more pallid coloration and larger skulls when compared with those of *cinerascens* from Pasadena, Los Angeles County. One specimen examined from the head of San Emigdio Canyon, Kern County, has the broadly expanded zygomata seen in *bachmani*, although it possesses the large auditory bullæ and short palatal bridge characteristic of the more southern coastal form.

Representatives from the San Fernando Valley are very pale in worn pelage as Allen (1890, p. 159) described the type (mentioned as an adult, but, according to the measurements given, probably a

subadult). In new pelage, as seen by one skin collected October 31, at Garnsey, they are richly colored and differ distinctly from the "gray-sided" brush rabbits of the *virgultus* or *howelli* type. A series from the vicinity of San Diego is even brighter in tone of coloration than specimens from Pasadena. They are, however, slightly smaller, tending, in respect to this character, toward *howelli*.

A careful comparison was made between the brush rabbits of the inner coast ranges of southern California and a series from the Sierra Juarez and Sierra San Pedro Martir of Lower California, the latter representing the race *S. b. howelli*. Regarding color these two series were almost identical, but were distinguishable cranially by the smaller auditory bullæ of the California-taken specimens. The latter were indistinguishable cranially from *cinerascens* from coastal San Diego County. Consequently, it appears most suitable to consider brush rabbits from the San Bernardino, San Jacinto, Santa Rosa and Cuyamaca mountains as intergrades between *cinerascens* and *howelli* as noted by Huey (1927, p. 68).

Measurements.—The average and extreme measurements of 4 adult males from Riverside and San Diego counties are as follows: Total length, 320.0 (310–333); tail vertebræ, 35.5 (31–40); hind foot, 71.0 (68–74); basilar length, 46.6 (45.8–47.3); zygomatic breadth, 29.9 (29.1–31.1); postorbital constriction, 9.8 (9.2–10.9); length of nasals, 25.5 (24.7–26.1); width of nasals, 11.6 (11.4–11.7); length of molar series, 11.4 (10.9–12.1); diameter of external auditory meatus, 5.0 (4.7–5.3); breadth of brain-case, 21.2 (20.8–21.6); length of palatal bridge, 4.2 (3.6–4.6). The average and extreme measurements of 11 adult females from Riverside and San Diego counties are as follows: Total length, 316.4 (305–330); tail vertebræ, 30.4 (20–40); hind foot, 70.0 (64–75); basilar length, 46.0 (44.5–47.3); zygomatic breadth, 29.6 (27.9–31.3); postorbital constriction, 9.7 (8.2–10.8); length of nasals, 24.9 (23.4–26.2); width of nasals, 11.3 (10.0–12.6); length of molar series, 11.2 (10.2–12.0); diameter of external auditory meatus, 4.5 (4.2–5.1); breadth of brain-case, 20.5 (19.6–21.2); length of palatal bridge, 4.2 (3.7–4.5).

Specimens examined.—A total of 54 from the following localities: Kern County: head of San Emigdio Canyon, 5700 feet altitude, 1. Ventura County: Cuddy Canyon, 2; Mt. Pinos, 3; Matilija, 5; Ventura, 1. Los Angeles County: 3 miles east of San Fernando, 1400 feet altitude, 2; Garnsey, San Fernando Valley, 1; near Pasadena, 9.

San Bernardino County: Reche Canyon, near Colton, 7; Santa Ana River, 5500 feet altitude, San Bernardino Mountains, 1. Riverside County: Carrizo Creek, 3000 feet altitude, Santa Rosa Mountains, 2; Dos Palmos Springs, 3500 feet altitude, Santa Rosa Mountains, 2; Kenworthy, 4500 feet altitude, San Jacinto Mountains, 3; Mt. Thomas, 6800 feet altitude, San Jacinto Mountains, 1. San Diego County: Grapevine Spring, 1; Cuyamaca Mountains, 1; Escondido (4 in collection Ralph Ellis), 8; San Marcos (collection Ralph Ellis), 2; San Diego, 1; Dulzura, 1.

LIFE HISTORY

HABITAT

The brush rabbit, in its geographic distribution, is strictly limited to the Pacific Coast region of North America, and occurs from the shore of the Columbia River in Oregon south, west of the main crests of the Cascade-Sierra Nevada Mountain systems, to the tip of the peninsula of Lower California. In California, throughout the greater portion of its range, we find the species associated with the Upper Sonoran chaparral belt. Where found away from true chaparral, as seen locally along parts of the Sacramento and San Joaquin rivers, an equally dense vegetal cover is inhabited. Truly, the vernacular name "brush rabbit" is appropriate as indicating the habitat requirement of the species as a whole.

In Butte County, along the eastern side of the Sacramento River, brush rabbits were seen close to dense clumps of willow and button-willow (*Cephalanthus occidentalis*) into which they would take refuge when disturbed during feeding hours (fig. 23). During the first week of October, 1933, some signs of this species were noted west of Stonyford, Colusa County, in thick chaparral composed of chamise (*Adenostoma fasciculatum*), buck-brush (*Ceanothus cuneatus*) and mountain mahogany (*Cercocarpus betuloides*). Along Stony Creek, at this same locality, signs were much more frequently seen at the edge of cattail (*Typha*) growths where there were dense stands of white melilot (*Melilotus alba*). Rabbit runways were numerous among the many stalks of this plant.

Near Navarro, Mendocino County, brush rabbits were seen to inhabit dense undergrowth along the margins of the redwood and Douglas fir forests. This undergrowth consisted of such plants as wild

lilac (*Ceanothus thyrsiflorus*), tan-bark oak (*Lithocarpus densiflora*), blackberry (*Rubus vitifolius*) and California rose bay (*Rhododendron californicum*).

In San Francisco, San Mateo, and Santa Cruz counties this species has frequently been observed along the coastal sand dunes in associations of *Lupinus arboreus*, *Artemisia pycnocephala*, and *Eriophyllum stachadifolium*. On July 19, 1933, while driving along the coast in Santa Cruz County, from the town of Davenport to a point



Fig. 23 --Typical brush rabbit habitat along the Sacramento River bottom land in Butte County, California. Photograph taken October 1, 1933

nine miles north, twelve rabbits were noted. The time of observation was between 6:10 and 6:30 P.M. which places the average speed of travel at twenty-seven miles per hour. Rabbits were seen as regularly near the undergrowth in the redwood and Douglas fir forests along the road as on the brushy coastal side of the mountains where chaparral broom (*Baccharis pilularis*) formed the dominant cover.

Along the inner portions of the coast range in San Mateo County, brushy canyons and hillsides, where there were small clearings, were invariably found to be inhabited by members of this species. The canyon floors and some of the more exposed ravines contained arroyo willow (*Salix lasiolepis*). Often growing in close association with this were wild rose (*Rosa californica*), poison oak (*Rhus diversiloba*) and blackberry, all of which provided brush rabbit shelter.

The scattered brush on the more open slopes consisted largely of chaparral broom, occasionally species of *Ceanothus* and *Arctostaphylos* were also present. Where these associations occurred near springs or seepages the sedges and rushes that frequently grew near by were penetrated by numerous rabbit runways.

In the Berkeley Hills, Alameda County, brush rabbits were observed in situations quite similar to those in which they were seen in San Mateo County.

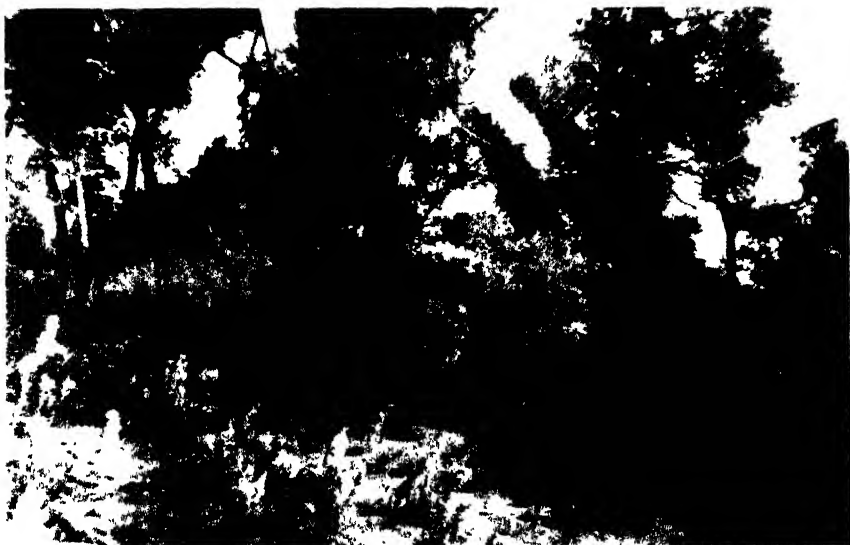


Fig. 24.—Thickets of willow and blackberry which provide shelter for brush rabbits living along the banks of the San Joaquin River in Stanislaus County, California. Photograph taken November 4, 1932.

Along the west side of the San Joaquin River, in Stanislaus and San Joaquin counties, this species was seen to inhabit the dense brush which occurs close to the river and to the nearby sloughs (fig. 24). Brush rabbits were never observed in very loose brush or in open fields, such as were commonly inhabited by cottontails in this same region.

In the extreme inner coast range of western Fresno County, near Waltham Creek, signs of brush rabbits were noted on chamise-covered hillsides. They were much more abundant, however, on the north and east-facing slopes where the brush was composed mostly of scrub-oak (*Quercus dumosa*), toyon (*Photinia arbutifolia*), snow-berry (*Symphoricarpus albus*), buck-brush and mountain mahogany.

Careful observations were made upon the habitat occupied by members of this species along the lower slopes of the Sierra Nevada in southeastern Fresno County during the month of December, 1932. Several snowfalls facilitated a careful determination of, by means of tracks, the exact regions occupied by rabbits. Signs of brush rabbits were noted from the lower margins of the Transition Zone, at 3000 feet altitude, above Miramonte, down to a point in the Upper Sonoran chaparral belt where the brush became so loosely scattered about as to provide an insufficient cover. At the highest locality, zonally, where the species was observed, there was a scattering of yellow pine (*Pinus ponderosa*) timber with an occasional incense cedar (*Libocedrus decurrens*). More commonly distributed were California black oak (*Quercus kelloggii*), buckeye (*Aesculus californica*), madrone (*Arbutus menziesii*), and in the more shaded canyons, California laurel (*Umbellularia californica*) and interior live oak (*Quercus wislizenii*). Intermingled with and growing beneath these trees was a large amount of brush, consisting chiefly of buck-brush and scrub oak. Occurring more sparingly was manzanita (*Arctostaphylos* spp.), coffee berry (*Rhamnus californicus*) and snowberry. Brush rabbits were fairly abundant in this undergrowth.

Just above this locality there was a precipitous rise to the main Sierra Nevada mountain mass, with a correspondingly abrupt floral change to a dominant yellow pine forest which was uninhabited by brush rabbits. Direct observation, as well as the statements of residents, attested to this fact. At a lower altitude the Transition trees and shrubs were largely replaced by Upper Sonoran forms such as blue oak (*Quercus douglasii*), buck-brush and scrub oak. Where the blue oak became more dominant and the brush of a much more open type, as was true below 2800 feet, no signs of brush rabbits were noted.

Grinnell and Swarth (1913, p. 369) mention this species in the San Jacinto Mountains as living in dense brush near Kenworthy. Regarding their occurrence at Dos Palmos, they make the following comment: "Here they were in typical desert surroundings, in our experience a most unusual environment for the species, and due, apparently, to their downward dispersion from the nearby Upper Sonoran hills."

GENERAL HABITS AND BEHAVIOR

Forms, burrows and trails.—While it is probable that in some instances brush rabbits inhabit burrows, they do not appear to make use of such refuges for shelter to the same extent as do Audubon cottontails. On July 7, 1931, near Lake Merced, San Francisco, a brush rabbit was observed along an equestrian path in the late afternoon. When close approach was made to this individual it hopped to the base of a eucalyptus tree nearby and disappeared into a hole located among the gnarled roots, which protruded above the surface of the ground. This is the only time that the writer witnessed a brush rabbit going into what might be termed a burrow.

Thorough examinations of a number of thickets inhabited by brush rabbits invariably showed these animals to be living in forms in the brush. These forms sometimes were located in dense portions of such thickets, among accumulated leaf litter and twigs. In other instances they were found in surface vegetation, such as rush, beneath or close to brush. These forms were merely cleared spaces, the dimensions of which roughly corresponded to the size of the inhabitant. The ground surface of these structures was often moist and covered with matted leaves and dead grass. Ten such forms were counted in one thicket which was fifteen yards long and eight yards wide and was composed of manzanita, blackberry and rush. A maze of runways was present connecting these forms together. Grinnell, Dixon and Linsdale (1930, p. 551), referring to situations occupied by members of this species in the Lassen Peak region of California, say as follows: "On the south side of Inskip Hill, association of brush rabbits and Streater wood rats beneath the dense scrub oaks seemed close, and significant in that the former had at least safety refuges, possibly breeding places, beneath the rat houses."

Due to the fact that brush rabbits live almost entirely in or close to dense vegetation, never venturing more than a few yards from cover, it is only natural that runways are used to a considerable extent. The outer entrances to these runways are readily apparent to an observer in brush rabbit country. They present a rounded, tunnel-like appearance. The twigs or stems which may be situated along such trails are either pushed aside or bitten off so as to allow sufficient room for the animals to pass in and out quickly. Where run-

ways lead through dense growth such as rush, the stems of these plants are frequently trimmed down to the surface of the ground along the course of these trails, while the stems of bordering rushes on either side incline toward each other so as to meet overhead and cover the path, thus forming a tunnel.

The various grasses and plants around the entrances to, or adjacent to runways appear never to be eaten when other food is available. This aids greatly in concealing these rabbit trails. Where patches of rush, sedge or tall grass grow around brush inhabited by these animals they usually contain such runways. In such cases they bear a marked resemblance to those of meadow mice, being, however, somewhat larger.

Examinations almost invariably revealed the presence of small forms or pockets if runways were followed one or two feet into undergrowth. These are "watching stations" or "lookout posts" where individual rabbits will remain for some time before coming out into the open to feed. They were found to contain much more excrement than did the trails. In one instance feces were found to be two inches deep in a form of this type in San Mateo County. The measurements of a number of such lookout posts varied from seven and five-eighths by eight and five-eighths inches to thirteen and three-quarters by nineteen and three-quarters inches.

Sometimes in late winter and spring, before the annual plants have attained an appreciable height, runways are not very apparent. During this part of the year small protected coves are most frequented. In late spring, as the annual vegetation becomes taller and provides suitable rabbit cover adjacent to the brush, runways are extended out farther. This seasonal variation with regard to extension of length of runways is evident in localities where bull thistle and fuller's teasel grow next to brush thickets. When trails such as those of cattle or deer are close to rabbit cover the runways of the rabbits are usually so directed as to join them. Brush rabbits were often noted foraging along these larger trails.

In the middle of December, 1932, near Miramonte, Fresno County, on the lower, western slopes of the Sierra Nevada the writer found numerous trails of brush rabbits in the snow. These trails were quite definite and seemingly well used. Usually they led from one clump of brush to another, often across small clearings ten to

twenty feet in diameter. Seldom were solitary tracks found. Although feces were commonly seen along such trails they were most abundant at feeding sites.

The width of a number of runways measured in San Mateo and Alameda counties varied from four and one-quarter to five and one-half inches. The farthest from brush that a definite runway was found to extend was ten feet. This led across an open clearing to a dense growth of bull thistle. The majority of runways examined were seen to lead out from brush, either straight or at a slight angle, for a distance of two to three feet. Here they usually joined another trail which ran parallel to the shelter.

Characteristic poses and movements.—Before coming out into the open to feed, brush rabbits remain a few minutes just inside the outer periphery of brush patches which they inhabit, apparently on the lookout for signs of danger. When marginal forms, previously described as "watching stations," or "lookout posts," are present these structures are used for this purpose. This was determined sometimes by direct observation and at other times by careful approach to such places from which rabbits could be roused just prior to the time at which they normally emerge to forage. In sage and lupine associations, along the coast, brush rabbits were often seen to maintain such watching attitudes for as long as twenty-five minutes before venturing into grassy clearings.

Upon emerging into the open, usually not more than a foot or two from brush, they remain motionless for a few minutes watching and listening for signs of danger. After this, if nothing unusual is detected, feeding begins at the edge of the grass nearest the shelter. A feeding individual immediately upon hearing an unusual sound will cease eating and hold its head erect. The nose is often twitched at such times, possibly to assist in catching scent of an enemy. If further alarmed the animal will hop toward the brush, sometimes stopping within several feet of cover, more often, however, disappearing completely from sight. After an individual is frightened into a thicket, providing it is not pursued, it is generally about six minutes before it again emerges into the open to feed. Likewise, even though it may have been out a considerable distance prior to being scared into the brush, feeding is resumed on the edge of the grass nearest the shelter.

Brush rabbits never attempt to go into the open to elude pursuit

They rarely even attempt to cross small clearings under such circumstances when it is possible to do otherwise. On the morning of December 18, 1932, near Miramonte, Fresno County, the writer was able, by means of a cautious approach, to gain a position which prevented a brush rabbit from returning directly to a dense thicket in which it lived. This animal was forced either to circle a distance of some thirty-five yards through open brush to arrive at the thicket from which it had been cut off, or to cross a small clearing to a nearby patch of chaparral. The latter course would have been much the easier of the two, but the rabbit chose to do the former.

Brush rabbits in their manner of moving about very much resemble cottontails. There is never any alternating movement of the hind legs and but little of the fore legs. The only times that the fore legs are moved separately is when individuals are slowly advancing to feed as they graze on low-growing vegetation or when they are digging.

Brush rabbits very often spend considerable time sunning themselves during the middle of the morning and in the late afternoon. Although this is usually done just inside the outer edge of the brush where sunlight is able to penetrate, individuals, on occasions, will sun themselves a short ways out in the open. On October 13, 1930, in Strawberry Canyon, Berkeley, California, a brush rabbit was seen to come from a wild rose thicket at 3:45 P.M. After emerging into the open it nibbled grass for several minutes close to another feeding individual. A few minutes later it hopped to the western side of a tall clump of wild oats situated about eight feet from the brush. Here it stretched out its fore feet as a cat would and sat facing the sun. The eyes were gradually closed and the ears lowered until they were parallel to and lying on the back. Occasionally the eyes were opened and the ears slightly elevated. This restful position was kept for almost one-half an hour. The greatest number of individuals were found sunning themselves on mornings after nights of heavy fog or rain or on sunny afternoons following mornings of rain.

The habit of thumping appears to be well developed among members of this species. This sound was most often seen to be made by individuals which were approached after they had first been frightened into shelter. When the observer remained quiet after a rabbit was first heard to thump, the animal would frequently appear to be uncertain as to the source of danger. Under such circumstances an

individual could very often be heard thumping regularly every two or three minutes for some time. In one instance a brush rabbit was heard to keep this up for a period of twenty minutes. Occasionally short, noisy dashes would follow thumps.

Rabbits living in small brush patches were never heard thumping. They were characterized by a quiet disappearance and noiseless movements.

Relation to each other and to other species.—Brush rabbits, while probably no more gregarious than various species of cottontails, appear to occur in greater numbers over given strips of habitable territory than do most other members of the genus *Sylvilagus*. In Golden Gate Park Stadium, San Francisco, where many observations were made on these rabbits, the writer, between July and October, 1934, found twenty-six brush rabbits inhabiting a strip of Australian tea hedge which was ten feet wide and one-half a mile long. These rabbits, when seen out feeding on adjacent lawn grass, were more or less evenly distributed along the course of this area, never being grouped together in numbers, although, occasionally, several would feed within a few yards of each other. Under these somewhat artificial yet optimum conditions each rabbit could be said to possess an average territory one hundred feet long and, as regards shelter, ten feet wide. The average feeding area available to each individual was of course approximately the same length as the home territory and, normally, not more than fifteen feet wide. Individuals were rarely noted out farther in the open.

Repeated observations were made upon rabbit numbers and distribution near Pescadero, San Mateo County, during the month of April, 1936. Along a section of road just south of this town conditions were very suitable for the presence of members of this species. A strip of grass varying from five to ten feet in width, grew adjacent to one side of the road. Back of this was dense brush forming a fine protective cover. Censuses of rabbits, taken regularly along this side of the road over a distance exactly one mile in length, repeatedly showed that at least twenty-nine individuals fed here. Certain limited sections of this strip, less desirable than others, rarely proved to possess any feeding individuals. On the other hand, more favorable tracts sometimes had two or three brush rabbits close together. As a rule, however, they were fairly well spaced. Of the total number observed six were young of the year, not more than one-third grown

when first noted. According to these figures each animal possessed an open ground feeding territory roughly about 182 feet long and between five and ten feet wide. The term open ground feeding territory is used because feeding was probably not entirely restricted to these exposed, grassy situations. Certain types of shrubbery are eaten to a slight extent even by those animals which have access to green grass in the spring. The figure given above for each individual's feeding territory appears perhaps a bit large in view of the fact that certain sections were not regularly used. On the other hand it must be remembered that some of the rabbits included in the count were young of the year which doubtless had not as yet sought territory of their own.

In no instances were individual brush rabbits ever seen to fight as a result of intrusion by other members of the same species upon their forage grounds. Although brush rabbits can normally be found in approximately the same feeding areas every day, as proven by observations made on crippled and other readily distinguishable individuals, they do not, so far as known, possess territories comparable to those of many birds which often will defend such domains against invasion by other individuals of the same species. Sometimes in country which affords good cover for members of this species few choice feeding localities will be present. Under such circumstances as many as a dozen brush rabbits may be found feeding within a few yards of each other in particularly attractive spots.

On several occasions brush rabbits were observed to sit facing each other in the open and at regular intervals jump simultaneously into the air, more or less exchanging places. These actions might possibly be interpreted as belligerent, but to the observer they appeared to be playful in nature. Similar actions have been noted among black-tailed jack rabbits. Very often in the late afternoon individuals will chase each other around in circles in the open and in and out of the edges of brush patches. They will suddenly stop, listen intently, and again resume such action. This behavior was observed frequently throughout the year, hence it is questionable if any sexual significance might be attached to it, at least during the fall and winter seasons.

Where black-tailed jack rabbits and Audubon cottontails occurred in brush rabbit country it was not unusual to find representatives of all three species feeding very close to each other. The

runways of brush rabbits were frequently observed to be used by California meadow mice (*Microtus californicus*) in San Mateo County.

Many birds such as California quail (*Lophortyx californica*), white-crowned sparrows (*Zonotrichia leucophrys*) and brown towhees (*Pipilo fuscus*) were noted feeding very close to brush rabbits along the margins of thickets. Warning calls given by these birds were commonly heeded by the rabbits. To cite one instance, in Strawberry Canyon, Berkeley, on September 12, 1930, a brush rabbit was seen feeding close to a flock of California quail (*Lophortyx californica*) in the late afternoon. The call notes given by these birds did not have any effect upon the rabbit. Suddenly a low call was given by one of the birds which caused the other members of the flock to remain perfectly quiet and cease feeding. Instantly the rabbit ran into the brush where it remained until the quail resumed feeding.

FOOD HABITS

Feeding places.--Most of the early evening and late morning feeding by members of this species takes place within the protective shelter of brush. Where grass is available close to shrubbery a great deal of the late evening and early morning feeding occurs in the open. At these times brush rabbits show a distinct preference for grassy coves along the margins of brush patches.

A preference is likewise shown for shaded feeding places. Areas are usually selected which are not in direct sunlight during the afternoon and morning periods of feeding. This was very well demonstrated to the writer in Golden Gate Park Stadium, San Francisco. The old race track which surrounds the Stadium is approximately a mile around, being oblong in shape with its longitudinal axis running east and west. The inner side of this track is margined by a hedge of Australian tea which is well inhabited by brush rabbits. These animals feed almost entirely upon lawn grass which extends around the Stadium as a strip, adjacent to the inner side of the hedge (fig. 25). On the south side of the Stadium the grass is well shaded in the early morning and late afternoon, during most seasons of the year, by the hedge which grows behind it. On the north side, however, it is almost continuously in direct sunlight from sunrise to sunset. Counts invariably showed the greater number of rabbits to

live on the south side, even though the grass and protective vegetation here in no ways differed from that on the north side. For example, on July 30, 1934, between 7:30 and 7:45 P.M. a census taken over the entire area showed four rabbits to be feeding on the north side and twenty-six on the south side. Furthermore, the four rabbits that were observed in the northern half of the Stadium were along the northwestern quarter where there was some shade in the late



Fig. 25 —Showing the effect of brush rabbit feeding on grass adjacent to a hedge in Golden Gate Park Stadium. Note the feeding individual in the center of the picture. Photograph taken September 6, 1931.

afternoon. Sunset on this evening was at 7:12 o'clock. On September 23, 1934, a similar count made between 6:00 and 6:12 P.M. revealed six rabbits feeding on the north side and twenty-three on the south side. As in the previous instance the rabbits recorded from the northern half of the Stadium were all in the northwest quarter. Sunset on this day was at 5:57 o'clock.

Sometimes seasonal changes will occur in local feeding sites. In one locality in San Mateo County where observations were made no grass was found growing within ten feet of a particular brushy tract inhabited by rabbits of this species. Instead, this strip between the brush and grassland was overgrown with fuller's teasel (*Dipsacus fullonum*), a non-native annual attaining a height of three to four feet. From late spring until autumn this plant served for protection

essentially as brush would, thus affording the rabbits opportunity to approach sufficiently close to the grass so that the latter could be eaten regularly. In winter and spring, however, when little remained of the previous year's stalks of fuller's teasel, the grass that was present was too far distant from the brush to be sought after extensively by rabbits. During these months the new young teasel plants constituted one of the principal items of food until they had grown sufficiently high as to permit access on the part of the rabbits to the grass farther out.

Times of feeding.—The same factors were found to affect the daily periods of feeding for brush rabbits as for Audubon cottontails. These are season of the year, fog, rain and wind. Furthermore, a very definite correlation was found to exist between the various phases of the moon and the period of night feeding for this species. As in the case of Audubon cottontails times were recorded in relation to sunrise and sunset, also the term maximum, in reference to population numbers, is used in the same sense (*cf.* p. 137).

On mornings that were normal, as regards climatic conditions, brush rabbits were noted out feeding in maximum numbers from dawn until four hours after sunrise. In winter individuals were frequently observed out until noon. Where feeding sites were somewhat exposed the number of rabbits out foraging dwindled rapidly later than three hours after sunrise. Afternoon feeding, in maximum numbers, was found to begin at one and one-half hours before sunset in places that were not too open. On dark nights this continued until one and three-fourths hours after sunset. When there was a full moon rabbits were seen feeding in the open in numbers until four and one-half hours after sunset. On such occasions certain individuals were often noted out until six and one-half hours after sunset.

Heavy morning fog was seen to deter the appearance of brush rabbits in the open until it was quite light. Similarly, in the evening, low fog caused feeding to cease at dark. Wind greatly interfered with feeding. The more forceful the wind the fewer rabbits were seen out. This indirect ratio continued proportionately until a maximum point was reached in the velocity of the wind after which no rabbits were seen. When a moderate wind was blowing in the morning or evening feeding took place principally within the cover of loose brush.

Heavy rain was definitely seen either to prevent rabbits from

emerging into the open to feed or to force them back into cover if they were already feeding in the open. Light rain or drizzle affected the feeding of these animals in the same manner as did fog.

Manner of feeding.—Brush rabbits rarely venture far into the open. Normally, when eating grass they will remain within five yards of shelter. The farthest that any individuals were recorded from cover at such times was fourteen yards. This was at dusk. Like cottontails, brush rabbits were noted farthest out in the open in the very early morning and late evening.

As is true of others of the rabbit family, members of this species give the appearance of creeping along when feeding on low grass. Where food is plentiful and the animals are undisturbed progress takes place slowly. When tall grass is present, as in late spring and summer, feeding individuals are frequently noted standing on their hind legs, with the fore legs limp at the sides of the body, in order to reach the tips of the blades for which a preference is shown. This same posture is often assumed when feeding on shrubbery. The latter type of food is chosen mostly in the late morning and afternoon.

When feeding upon roots, such as those of poison hemlock, brush rabbits were seen to dig with a fast alternating movement of the fore feet, the hind feet at such times being braced and held far forward. After the top of a root was exposed the stem was cut off and that portion of the root in evidence was eaten. Following this, digging was continued until more of the edible root was uncovered. Rarely were roots exposed to a depth of more than three inches below the surface of the ground. On one occasion a rabbit was seen to carry in its mouth a root which it had pulled up. This was taken to a runway entrance where it was eaten. Since the root had been dug up in an opening about four yards from shelter the act seemed to be protective.

Where clumps of rushes or open brush were growing along the margins of grassy clearings frequented by brush rabbits for feeding, these animals frequently remained within a yard or two of such shelter, thus rendering themselves less conspicuous.

In traveling from one foraging ground to another a route is almost always selected which leads through brush rather than across openings. The greatest distance in a straight line that a single individual was observed to travel at any one time to arrive at a new feeding site was twenty-five yards. Exceptions were occasionally en-

countered where rabbits were seen to hop ten yards or so along the outer edge of brush.

Food plants and seasonal variation with respect to food eaten.— Various edible grasses form the most important food items for this species throughout the greater portion of its range. Many other kinds of plants, however, are consumed, especially during the late fall and winter months when grass is scarce or entirely lacking.



Fig. 26—A brush rabbit in Golden Gate Park, San Francisco. Photograph taken by Mr. Frank L. Rogers, December 17, 1937

In the latter part of September, 1933, along the east side of the Sacramento River in Butte County, brush rabbits were observed feeding principally on creeping eragrostis (*Eragrostis hypnoides*) spike rush (*Eleocharis palustris*).

In the San Francisco Bay region, more specifically in Strawberry Canyon, Berkeley, Golden Gate Park, San Francisco, and on the San Francisco Water Department property in San Mateo County, quite a number of different plants were seen to be eaten by brush rabbits. Foxtail grass (*Hordeum murinum*), soft chess grass (*Bromus hordeaceus*) and oat grass (*Avena fatua*) were of first preference when and where available. Many other species of grasses undoubtedly are also eaten. During summer, when the grass was dry a considerable quantity of green herbs and shrubs was consumed. Rabbits, at this time were noted eating such species as wild rose (*Rosa californica*),

Mexican tea (*Chenopodium ambrosioides*), sow thistle (*Sonchus asper*) bull thistle (*Cirsium lanceolatum*), *Baccharis douglasii* and rush (*Juncus* spp.). In fall these same species and, in addition, the roots of poison hemlock (*Conium maculatum*) and the leaves and stems of blackberry (*Rubus vitifolius*) were eaten. In several localities during fall and winter the roots of poison hemlock constituted the principal food supply. The soil where this plant was found growing was generally moist and loose, hence easy to dig. The roots are reported to be quite poisonous but the rabbits seemed to suffer no ill effects. The stems and leaves were bitten off but never eaten.

In winter, when new green grass appeared, fewer herbs and shrubs were taken and grass once again formed the dominant item of food. In one locality in San Mateo County, however, where green grass, for reasons already given (p. 181), was unavailable until late spring, fuller's teasel (*Dipsacus fullonum*) was seemingly the most important food plant in winter and early spring. Around the margins of lakes silver-weed (*Potentilla anserina*) and water pennywort (*Hydrocotyle ranunculoides*) were often eaten.

Along the San Mateo County coast in the vicinity of Pescadero, between February and May, 1936, lupine (*Lupinus arboreus*), next to grass, constituted the most important food of brush rabbits. The stems were eaten principally, the leaves as a general rule being discarded. Where green clover (*Trifolium involucriatum*) was present it was chosen in preference to all other plants, even grass. Coyote brush (*Baccharis pilularis*) was seen to be eaten by rabbits on one or two occasions.

Grinnell and Storer (1924, p. 230) state that in Mariposa County, in the fall months, blue brush (*Ceanothus cuneatus*) and wild broom (*Hosackia glabra*) form important articles of food for brush rabbits, the stems being eaten in preference to the leaves.

Observations made by the present writer near Miramonte, Fresno County, California, at an altitude of 3500 feet, in the middle of December, 1932, showed brush to be the only type of food eaten by members of this species at this season of the year. The tracks of these rabbits in the snow were found leading to bushes of scrub oak (*Quercus dumosa*), buck-brush (*Ceanothus cuneatus*), red berry (*Rhamnus crocea*) and snowberry (*Symphoricarpos albus*). The bark of the last three mentioned forms was occasionally seen to be stripped. The stems, however, were more commonly eaten, often to a height of ten

inches above the ground. The leaves appeared to be only partly eaten or else dropped entire upon the snow. As a general rule fresh feces and urine were found deposited on the snow where any lengthy feeding had taken place.

Toward the end of December of this same year, along Waltham Creek, south of Priest Valley in western Fresno County, brush rabbits were noted feeding to a considerable extent on an unidentified species of the genus *Eriogonum*.

Judging from personal observations and those of other persons brush rabbits are adapted to subsist upon a wide variety of plants, depending largely upon the availability of these species.

REPRODUCTION

Breeding season.—The breeding season of brush rabbits, so far as known, is largely limited to that period of the year extending from January to June. On January 3, 1931, in Golden Gate Park, San Francisco, what appeared to be an attempt at mating between two individuals of this species was observed. In this instance the female, presumably, avoided the male by running in small circles. This took place during the middle of the day. Embryo records are had for the months from January to June, exclusive of February. Young one-quarter grown have been taken during every month from March to September, and young from one-third to one-half grown have been taken during all months from February to August. All specimens examined, taken between October and December, inclusive, are either completely or, as seen in some early October-taken individuals, almost in full adult pelage. This would seem to indicate that young are rarely born after the middle of summer.

Rate of reproduction.—We may conclude, since all early winter-taken specimens are in adult pelage, that but four or five months elapse between birth and maturity.

Records indicate that in the area immediately surrounding San Francisco Bay the greatest number of females are pregnant during March, April, and June. During these months, however, many young from one-fourth to one-third grown have been noted, showing that a certain number of young have been born earlier in the spring, possibly in the latter part of February.

In the Museum of Vertebrate Zoölogy there are 14 specimens of brush rabbits taken in Marin and Sonoma counties, all in the same

year, between the latter part of May and the middle of June. Six of these are young varying from one-third to one-half grown, another is about three-fourths grown. Six more are adult females, two being pregnant when taken and a third having given evidence by the condition of the mammary glands that she was nursing young. This indicates two peaks to the reproductive period in this instance, one probably in March and another in June.

Near Pescadero, San Mateo County, in the spring of 1936, the first young were seen on April 1. These were three individuals which were being carried by a weasel. They did not appear to be old enough to leave the nest. By the end of the second week in April many young about one-fourth grown were seen out feeding in the evening and early morning. By the end of April most of the young were about one-third grown. By the middle of May many half-grown young and a few individuals barely one-quarter grown were seen.

Records of 11 pregnant females from central and northern California showed the mean number of embryos per adult female to be 3.5 with extremes of 2 and 5.

Nests and young.—Seemingly brush rabbits construct a nest wherein the young remain during the first weeks after birth, as do most other members of the genus *Sylvilagus*. These nests are usually well concealed, so much so that it is only by mere accident that they are occasionally discovered. It is quite probable that at birth brush rabbits possess a very short, fine pelage, somewhat similar to that of young cottontails. Mr. E. Lowell Sumner, Jr., told the present writer of a female captured in a box trap during the night of April 10, 1933, in San Mateo County, which gave birth to a litter of young before morning. He was sure that these young brush rabbits had a fine, thin, silky pelage covering most of the body. The young do not open their eyes until several days after birth.

On April 2, 1931, Miss Mary M. Erickson (MS) found a brush rabbit nest in Strawberry Canyon, Berkeley, California. Her attention was first called to the site by the squealing of one of the three young occupants that was being eaten by a gopher snake. The nest was situated in a small, grassy clearing just a few feet from some brush. It was so well concealed, however, by the surrounding vegetation and, additionally, by the grass plug which covered the top of the nest that it would have been passed unnoticed at very close range were it not for the squealing of the young. Whether or not a cavity

had been excavated in the ground before the nest was built was not determined. The nest itself was composed of dry grass and rabbit fur and completely surrounded the young. The latter, when first discovered, were furred but did not as yet have their eyes open. Two days later the eyes were beginning to open. A return to the nest at 10:00 A.M. on April 7, showed the young to be old enough to leave the nest and at 3:30 P.M. the same day the nest was found to be vacant. The plug of grass covering it had not been removed, hence it was not known whether they had left of their own accord or had been the victims of some predator. The latter suggestion seemed doubtful, since there were no signs indicating any forcible removal.

Davis (1936, p. 36) records the finding of a nest containing three young brush rabbits in this same general locality. As was true of the previously described nest this structure was out in open grassland some distance from brush, and was lined with rabbit fur, presumably plucked from the female parent's body.

Gander (1929, p. 55) mentions taking young brush rabbits from woodrat huts near San Diego, California, but does not comment upon any nest.

On May 14, 1931, in Golden Gate Park, San Francisco, the writer had the opportunity to observe a brush rabbit building a nest. The animal was seen at 1:00 P.M. on a bank that was loosely overgrown with blackberry vines next to a clump of denser brush. It had scooped out a small hollow about the size of its body in the bank beneath some of the blackberry stems. During the ensuing few minutes ten trips were made to a point about three feet down the incline to gather dead blackberry and acacia leaves and long stems of dry grass which were carried back in the animal's mouth and placed in the cavity. The muzzle and front feet were used in arranging the lining material. Undoubtedly this rabbit was constructing a nest for young, but, unfortunately, the writer was called away for the next two months and was unable to make further observations.

Behavior of young.—On March 29, 1932, a young brush rabbit that had been taken from the nest the previous day was received by me. The captor had fed it milk from a pipette several times during the first 24 hours of captivity, and the young animal appeared perfectly normal. At this time (March 28) the eyes were unopened but the body was almost totally haired except for the toes, the elbows, and axial regions of the fore legs. The rabbit was estimated at this time

to be about a week old. Its weight at 9:30 P.M. on the day it was received was 45.7 grams, the hind foot measured 27 millimeters and the ears from the notch, 16.4 millimeters. The fur was quite short and closely adpressed to the body, although the guard hairs were quite noticeable.

Several interesting points were observed regarding its behavior at this early period. The ears were in no case held erect, but lay down over the neck and back. Whenever it was touched it would emit a loud squeal and make an attempt to jump, which amounted to little more than a kick of the hind feet. After being fed from a dropper the front and hind feet were licked thoroughly. All movement about was very unsteady and the result of alternate movement of the fore and hind legs. Essentially it would be termed crawling since there was no indication of hopping. When resting, most of the time was spent on the side rather than sitting hunched up.

On March 30, early in the morning, the first definite reaction to light was noted and this was a negative one. When an electric light was turned on the young rabbit attempted to hide beneath some cotton. On the evening of the same day the eyelids were very slightly opened, sufficiently so, however, to gain a reflection from the eyeball.

During the entire period that this young individual was kept under observation it was fed milk at intervals of about two hours. Weights were not kept due to the fact that they would not be indicative of the normal growth of the body under natural conditions, hence might be misleading.

On March 31, the eyes were about one-fifth open. On April 1, the eyes were almost completely open and it was seen to hop for the first time. Evidence of reaction to motion made by the observer was also seen. A small amount of grass was eaten for the first time. At this period the animal ceased squealing when held in hand. The following day the eyes were completely open and hopping was resorted to more often than crawling. Likewise, the ears were slightly elevated. It is interesting to note that all during the period that the young was kept it could almost invariably be induced at any time to lick itself by stroking the fur. This is probably the normal reaction when the parent licks the young.

More grass was eaten on April 2 and 3. On the latter date the fur appeared quite thick in contrast to the condition noted at the time of capture. On this date also crawling was used only when an effort

was made to climb over small obstacles, otherwise all travel was accomplished by hopping. An accident resulted in the animal's death on this date, hence observations ceased.

The amount of time required from birth until the nest is left is not known but judging from the above observations it would appear to be about two weeks or slightly over.

On April 13, 1936, near the mouth of Pescadero Creek, San Mateo County, a young individual about one-quarter grown was observed feeding with an adult in a small grassy place close to some brush. The adult, presumably the mother, would not suckle the young. Several attempts on the part of the latter met with rebuff and resulted in its being chased into the shrubbery.

NATURAL ENEMIES

Mammals.—Bobcats (*Lynx rufus*), coyotes (*Canis latrans*) and gray foxes (*Urocyon cinereoargenteus*) all contribute toward a reduction of the brush rabbit population. Stray house cats in Golden Gate Park, San Francisco, were on several occasions seen carrying off brush rabbits that had been freshly killed, and were also noted more than once stalking individuals of this species in San Joaquin County.

On April 1, 1936, near Franklin Point, San Mateo County, California, the writer observed a long-tailed weasel (*Mustela frenata mignauris*) to carry three young brush rabbits from their nest to its burrow. A separate trip was made for each of the rabbits. Dixon (1925, p. 41) records the finding of a brush rabbit in the stomach of a gray fox.

Birds.—Bryant (1918, p. 127) records the presence of *Sylvilagus b. cinerascens* in the stomach of a western red-tailed hawk (*Buteo borealis calurus*). Sumner (1929, p. 90) also mentions finding a brush rabbit (*Sylvilagus b. cinerascens*) in the nest of a western red-tailed hawk. On September 22, 1934, near the Municipal Golf Links, Oakland, California, Mr. Dawson A. Feathers (MS) saw a Cooper hawk (*Accipiter cooperi*) fly from the ground at 5:00 P.M. Closer investigation showed the hawk to have been feeding on a brush rabbit which had been freshly killed, the animal still being warm with blood flowing. To all appearances the killing was done by the hawk which had punctured the thoracic cavity on the left side near the heart.

Remains of brush rabbits found in barn owl (*Tyto alba*) pellets

in the vicinity of Berkeley, California, are recorded by Hall (1927, p. 274) and Foster (1927, p. 246). Grinnell, Dixon and Linsdale (1930, p. 233) mention remains of young brush rabbits found in barn owl pellets taken along the Sacramento River, north of Red Bluff. Without doubt the horned owl (*Bubo virginianus*) is also an important natural enemy of this species. During the week of February 11, 1935, a pellet, thought to belong to one of these owls and containing remains of an adult brush rabbit, was found in Strawberry Canyon, Berkeley, by Dr. Sumner Brooks of the University of California.

On March 16, 1932, in Hamilton Gulch, Berkeley, California, Miss Mary M. Frickson (MS) heard the squeal of a young brush rabbit. Upon further search it was seen that a California jay (*Aphelocoma californica*) was pecking the young animal, which was almost dead and was wedged beneath the low horizontal branches of some chaparral broom (*Baccharis pilularis*). At about the same time (approximately 9:15 A.M.) another squeal was heard a short distance away. When the source of the last mentioned call was sought after, a California jay was found near another young rabbit. This individual, when touched, ran up the observer's sleeve. Upon returning a few moments later to the place where the first young rabbit had been found the latter was missing. Whether it had been carried away by a jay or some other animal during the interim, or whether it had recovered sufficiently so as to run away was not known.

Again in this vicinity on March 28, 1932, the same observer (Frickson, MS) saw a California jay carrying a small, squealing brush rabbit in its bill. A second jay was noted at the same time pecking at another young rabbit which was also squealing. This rabbit upon closer scrutiny was seen not to have its eyes open as yet.

Reptiles.—Rattlesnakes and gopher snakes are important natural enemies of brush rabbits, especially when the latter are young. On May 24, 1933, Mr. E. Lowell Sumner, Jr. (MS) found a small brush rabbit in the stomach of a rattlesnake (*Crotalus confluentis*) that was killed on the Alpine Creek Ranch, San Mateo County, California. Mr. Sumner likewise found another small rabbit in the stomach of a rattlesnake taken in this locality on June 14, 1933, and, on July 15, 1933, a very large rattler was killed containing the posterior half of an adult brush rabbit.

In Hamilton Gulch, Berkeley, California, on April 2, 1931, Miss

Mary E. Erickson (MS) saw a gopher snake (*Pituophis catenifer*) enter a rabbit nest containing three young which still had their eyes closed. The snake proceeded to pick up one of the young by the middle, but, when probed with a stick, dropped it and retreated farther into the nest out of sight. A squeal was heard a moment later and the head of the snake appeared with the head of one of the rabbits in its mouth. It held on to this even though it was pushed some distance away from the nest by the observer. The process of swallowing took twenty minutes. The greater part of this time being spent in moving the jaws over the rabbit's head. After the meal was completed the reptile started to go directly back to where the two other young were located, but was interrupted before it succeeded in doing so.

Sylvilagus idahoensis* (Merriam)*PIGMY RABBIT**

Plate 10, figures 5, 6

Lepus idahoensis MERRIAM (1891, p. 75), original description.

Lepus (Brachylagus) idahoensis, MILLER (1900, p. 157), new subgenus.

Brachylagus idahoensis, LYON (1904, p. 411); NELSON (1909, p. 275).

Sylvilagus idahoensis, GRINNELL, DIXON and LINSDALE (1930, p. 553).

Type.—Adult male, skin and skull; No. 24045/3 1461, United States National Museum, Biological Survey collection; from Pahsimeroi Valley, Custer County, Idaho; collected September 16, 1890, by Vernon Bailey and Dr. B. H. Dutcher, United States Army; original No. 1816.

Geographic distribution.—Occurs locally in the Great Basin region of northeastern California. Zonal range, Upper Sonoran and low Transition (fig. 19). Altitudinal range, so far as known from specimens collected in California, 5000 to 5300 feet.

Diagnosis.—Size, very small, with total length of adults varying from 230 to 295 mm.; hind legs very short; hind feet comparatively broad and heavily haired; ears short, rounded and densely covered with a silky type of pelage, both inside and out; vibrissæ black and white; adults undergoing but one annual molt; tail very small, dusky above and below; rostrum proportionately short and pointed; supraorbital processes moderately large; antorbital projections of supraorbital processes very long compared with those of other members of the genus *Sylvilagus*; postorbital extensions of supraorbitals instead of tapering to a blunt end, as seen in other species, are broadest distally with this end either truncate or slightly notched; jugals moderately slender; brain-case relatively large; anterior palatine foramina very broad posteriorly and rarely showing any indication of a constriction; palatal bridge short, usually possessing a postero-median spine; auditory bullæ comparatively large; molariform teeth relatively small; anterior surface of first upper molariform tooth possessing but a single re-entrant angle; posterior halves of the second to the fourth lower molariform teeth possessing lateral diameters equal to about one-half of the lateral diameters of the anterior halves; ridge of enamel separating individual molariform teeth into anterior and posterior sections lacking any crenulation.

Adult fall pelage.—The following description, which attempts to cover the normal range of individual variation in color, is based upon series of specimens in fresh fall pelage from northeastern California and central Nevada. Subterminal band of guard hairs on top

of head and back varying from pale ochraceous-buff to nearly light pinkish-cinnamon; terminal band of black very conspicuous on some specimens, whereas on others it is almost entirely lacking; sides noticeably paler than back, due to reduction or absence of terminal band of black on guard hairs and appearance of an intermediate band; vibrissæ mostly black with one or two whitish whiskers; areas extending from sides of nose to anterior parts of circumorbital regions and from posterior parts of circumorbital regions to bases of ears grayish, due to combined presence of an apical band of black and a subterminal band of white on guard hairs; anterior outer parts of ears grizzled, not unlike top of head, and frequently becoming blackish at tips; hairs on outer posterior parts of ears nearly cinnamon-buff, becoming slightly more pinkish close to bases, whereas near tips of ears they possess an apical band of black; inner posterior parts of ears rather heavily covered with light buff-colored hairs, these being somewhat brighter in tone near margins of ears; tops of fore legs and fore feet nearest light ochraceous-buff, with some of hairs occasionally possessing a terminal band of black; backs of hind legs above heels and tops of hind feet slightly paler than fore legs and fore feet; chest similar in color to sides; tail buffy above with hairs at tips sometimes possessing a noticeable amount of black tipping; underside of tail dusky; guard hairs on ventral parts of body nearly slate gray at base, becoming either pure white or slightly buffy distally.

Juvenile pelage.—Subterminal band of overhairs on back and top of head between pale pinkish-buff and pinkish-buff; much of underfur showing through this, resulting in a generally darker appearance than seen in the case of the adult pelage; nape cinnamon-buff; tail inconspicuous with the more distally located hairs of the dorsal surface black; underside of tail dusky; tops of fore legs and hind legs above heels between light ochraceous-buff and pinkish-buff; hairs on underside of body white, distally, except in chest region where coloration is similar to that of sides.

Postjuvenile pelage.—Differing most noticeably from adult pelage in that the hairs are shorter and the general appearance darker due to a broader terminal band of black on guard hairs of sides; posterior outer parts of ears and nape somewhat paler than seen in adult pelage; this is true also of tops of fore legs and hind legs above heels.

Remarks.—An adequate discussion of the reasons for considering

the genus *Brachylagus*, proposed by Lyon (1904, p. 411), as synonymous with the genus *Sylvilagus* has already been given by Grinnell, Dixon and Linsdale (1930, pp. 555-562). Further comment by the present writer, who concurs in full with the opinions of the above authors in this regard, would be superfluous.

Measurements.—The average and extreme measurements of 6 adult males from eastern Lassen County are as follows: Total length, 272.0 (252-285); tail vertebræ, 17.5 (15-20); hind foot, 69.7 (67-76); ear from crown, 60.8 (59-64); basilar length, 38.9 (36.9-40.9); zygomatic breadth, 27.3 (26.4-28.2); postorbital constriction, 9.2 (8.5-9.5); length of nasals, 19.1 (18.2-19.6); width of nasals, 9.2 (8.4-10.0); length of molar series, 9.2 (9.0-9.4); diameter of external auditory meatus (5 averaged), 5.1 (4.8-5.4); breadth of brain-case (5 averaged), 20.2 (19.7-20.8); length of palatal bridge (5 averaged), 4.1 (3.3-4.6). The average and extreme measurements of 9 adult females from eastern Lassen County are as follows: Total length, 275.3 (230-295); tail vertebræ, 18.7 (15-24); hind foot, 71.7 (67-75); ear from crown, 59.0 (56-61); basilar length, 39.3 (37.5-41.0); zygomatic breadth, 27.3 (26.4-28.3); postorbital constriction, 9.5 (8.9-10.5); length of nasals, 18.8 (17.6-20.4); width of nasals, 9.7 (9.1-10.4); length of molar series, 9.1 (8.8-9.6); diameter of external auditory meatus, 4.9 (4.6-5.4); breadth of brain-case (8 averaged), 20.0 (19.4-20.6); length of palatal bridge, 4.0 (3.5-4.6).

Weights.—The average and extreme weights of 6 adult males from eastern Lassen County are 409.3 (375-435) grams. The average and extreme weights of 9 adult females from eastern Lassen County are 397.8 (246-458) grams.

Specimens examined.—A total of 20 from the following localities: Lassen County: 7 miles east of Ravendale, 5000 feet altitude, 19; 3 miles south of Ravendale, 5300 feet altitude, 1.

LIFE HISTORY

HABITAT

The pigmy rabbit, the smallest known member of the Leporidae, is not only limited in a spatial sense with respect to its geographic range but is also strictly confined to one very definite type of environment. Individuals of this species have been observed only in localities where sagebrush (*Artemisia tridentata*) is dominant. To be even

more specific, it may be stated that sagebrush of a particularly tall type, growing in dense clumps, is usually an essential ecological factor requisite for the presence of the species (fig. 27).

Grinnell, Dixon and Linsdale (1930, p. 553) characterize areas wherein pigmy rabbits were observed in eastern Lassen County, as possessing large patches of tall, densely growing sagebrush with the leaves matted at the bases of the bushes. Dice (1926, p. 27) found



Fig. 27 Tall sagebrush inhabited by pigmy rabbits, six miles east of Ravendale, Lassen County, California. Photograph taken October 24, 1931

these rabbits in a similar situation, saying as follows: "This species was found only in one restricted area ten miles north of Baker, Baker County, Oregon, in late June. This was in a patch of old sagebrush, four to six feet in height, growing on the gently sloping, alluvial fan of a small ravine debouching into a broad valley. This patch of high sagebrush was about fifty yards in width on the average, about three hundred yards long, and was surrounded by low sagebrush of the general region."

The above descriptions are typical of places where the writer found pigmy rabbits on the south edge of the Madeline Plains, east of Ravendale, Lassen County, in October, 1931 (fig. 28). Two "colonies" of these animals were located. One of these was situated in a ravine where the floor broadened out to a width of approximately thirty yards before coming down onto the plains. The bushes of *Artemisia* were much taller and more matted at their bases on the flat

ravine bottom where the rabbits were noted than was true of those seen growing on the canyon walls on either side. The second "colony" was found on the very edge of the plains proper, approximately one-half mile north of the above described location. A similar type of sagebrush, although somewhat less matted basally, was encountered here, covering an area about one hundred yards in length and one-third that distance in width. The surrounding area, grown over with



Fig. 28.—Territory inhabited by pigmy rabbits, six miles east of Ravendale, Lassen County, California. Photograph taken October 23, 1931.

rabbit brush (*Chrysothamnus nauseosus*) on one side, short sagebrush on another, and old sagebrush growing on rocky ground on a third side, was devoid of pigmy rabbits. The tall sage was found only where the soil was loamy in texture and almost entirely lacking in rock.

In Big Smoky Valley, near Millett Post Office, Nye County, Nevada, this species was seen to inhabit patches of tall sagebrush (Linsdale, MS).

While pigmy rabbits are probably not always limited to sagebrush of this tall type, field records have shown this to be true in nearly every instance of observation. The quality of the soil is undoubtedly an important distributional factor for this species although little information is at hand regarding its influence. If, as has been supposed by some authors, pigmy rabbits dig their own burrows, alluvial silt or loam free from rock would seem to be preferable to clay-like,

rocky or gravelly ground. The former type of soil is that in which tall sage is generally found. It appears more likely, however, that the shelter afforded by these localized patches of taller sage account for its association with this diminutive species of rabbit which is not equipped with the power of rapid locomotion for more than short distances.

GENERAL HABITS AND BEHAVIOR

Burrows are regularly used by members of this species. Whether these places are used exclusively or not in preference to forms is not definitely known. Anthony (1913, p. 23) says that "Where their favorite conditions prevail, none were seen at burrows, and I think that here the thick brush affords ample protection and the surface form answers all the requirements for a home, at least during the summer. In such a spot, rabbits when seen were always started from under the brush and rarely did I drive one to a burrow, as the animal would double and turn and seek to hide in the brush, a proceeding he would not be apt to resort to if he had a burrow nearby in which he was accustomed to seek refuge." Based upon personal observations on the behavior of members of this species as well as upon several forms of cottontails, the writer is inclined to disagree with the last statement made above. Most rabbits are rather wary about running directly into their burrows when closely followed. Pigmy rabbits have been observed to run out of their burrow entrances rather than enter when suddenly frightened. This appears to be a protective type of behavior resorted to in order that inquiry or pursuit may be directed away from their homes.

Burrows are usually located at the bases of sage clumps (fig. 29). They are seldom of any great length and generally have two entrances. One burrow, excavated in eastern Lassen County, proved to be eight and one-half feet in length from one entrance to the other. Two side tunnels led off from the main tunnel. One of these was a short, blind pocket. The other branched into two parts, one of these being a blind pocket, the other an old entrance which had been plugged with earth. The deepest part of this burrow was twenty-six inches below the surface of the ground. The average height and width of the tunnels was six and four inches, respectively. Feces and small pieces of sagebrush were found in the burrow but no nest was present. Grinnell, Dixon and Linsdale (1930, p. 553), discussing burrows occupied by members of this species in eastern Lassen County,

make the following statement: "Nearly all the burrows were less than one meter in length and most of these were less than one-half meter below the surface."



Fig. 29.—Mouth of a pigmy rabbit burrow, six miles east of Ravendale, Lassen County, California. Photograph taken October 24, 1931.

With regard to the apparent colonial habits of these animals it is the writer's opinion that this is more accidental than it would at first appear. The habitat in which the pigmy rabbit is found, that

is, the tall sagebrush association, is not of common occurrence. If these tall sage patches were more extensive, or, on the other hand, the rabbits themselves were not so limited to this restricted type of

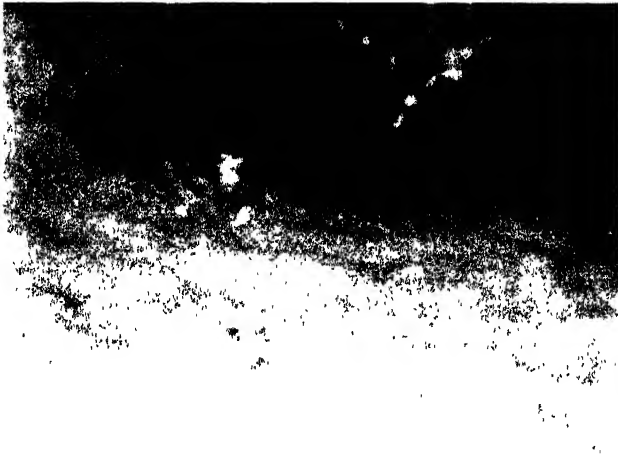


Fig. 30 — Pigmy rabbit tracks in fresh snow, six miles east of Ravendale, Lassen County, California. Photograph taken October 26, 1931.

environment this species would likely appear no more colonial than Nuttall cottontails, which occur within the same general area.

It is not known whether these rabbits follow definite trails. Their

manner of hopping resembles that of other rabbits, but, due to their small size, they do not appear to bound into the air as do members of most other leporid species. Measurements of tracks made in the snow showed that when running across small clearings in the brush footprints average about twenty-two inches apart. Imprints of the hind foot varied from two and one-half to two and three-fourths of an inch in length (fig. 30).

Regarding the association of pigmy rabbits with other members of the Leporidae Anthony (1913, p. 23) says as follows: "Young cotton-tails and black-tail rabbits were seen in the same thick cover with *Brachylagus*. . ."

FOOD HABITS

The food of these rabbits, so far as known, consists almost entirely of sagebrush. This, of course, is the most abundant form of vegetation in localities where this mammalian species occurs. Possibly, in the spring of the year, certain annual plants which are present may also be eaten. In eastern Lassen County, in the fall of 1931, tracks followed by the writer in the snow indicated that pigmy rabbits will travel as far as thirty-eight yards from their burrows to feed. One circuit made by a foraging individual measured approximately ninety yards although this animal was never more than one-third of this distance in a straight line from the hole in which it lived. Pieces of cut sagebrush and tracks on the surface of a fresh fall of snow clearly indicated that this animal had stopped several times to feed. On a number of occasions feces and urine were found deposited in places where individuals had fed.

Feeding takes place during the early morning and evening hours, and also to a considerable extent at night. Anthony (1913, p. 23) in speaking of the habits of pigmy rabbits in Malheur County, Oregon, says: "I could be as reasonably certain of seeing *Brachylagus* in the daytime as I could of finding *Sylvilagus*, and the same feeding habits and hours seem to apply to one as to the other."

On October 26, 1931, on the Madeline Plains, Lassen County, the writer observed many tracks of this species at dawn. As it had snowed the night before until after midnight these tracks were necessarily made by individuals which had been out foraging before dawn that morning.

REPRODUCTION

Judging from what little information is now at hand the writer is led to believe that the breeding season of the pigmy rabbit is limited to the spring of the year. Two pregnant females collected by Mr. William B. Davis on May 28 and 30, 1934, respectively, near Riddle, Owyhee County, Idaho, each contained six embryos. Those of the first-taken female measured sixty millimeters in length and of the last seventy millimeters. These were, in the collector's estimation, nearly ready for birth. They were entirely naked. A female taken by Miss Annie M. Alexander at Bell's Ranch, Reese River, Nye County, Nevada, on June 4, 1925, contained six embryos. The following day three young, between one-half and one-third grown, were taken at this same locality.

Individuals approximately half-grown or less have been taken during the months of June and early July. Dice (1926, p. 28) mentions several small young seen between June 20 and 26, north of Baker, Baker County, Oregon.

In the collection of the Museum of Vertebrate Zoölogy are a large number of specimens representing this species, taken in December and January. Every one of these is in adult pelage thus indicating the improbability of young being born in the fall of the year.

NATURAL ENEMIES

Little of a definite nature is known concerning the enemies of this species. It is probable, however, that many of those forms which prey upon other members of the genus also take toll from the pigmy rabbit populations. Borell and Ellis (1934, p. 42) mention finding the remains of a pigmy rabbit in the crop of a long-eared owl (*Asio wilsonianus*).

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PLATE 1
(Natural size)

Lepus townsendi townsendii Bachman. Adult male, No. 47067, Mus.
Vert. Zool., from Virginia, Bannock County, Idaho.
1. Dorsal view.
2 Ventral view.





PLATE 2
(Natural size)

1, 2. *Lepus washingtoni klamathensis* Merriam. Adult male, No. 32186, Mus. Vert. Zool., from McCloud, Siskiyou County, California. Dorsal and ventral views.

3, 4. *Lepus washingtoni tahoensis* Onn. Adult male, No. 37522, Mus. Vert. Zool., from near Tahoe City, Placer County, California. Dorsal and ventral views.

PLATE 3
(Natural size)

1. *Lepus californicus californicus* Gray. Adult male, No. 3811, Calif. Acad. Sci., from Red Bluff, Tehama County, California. Dorsal view.
2. *Lepus californicus richardsoni* Bachman. Adult male, No. 1028, Calif. Acad. Sci., from Buttonwillow, Kern County, California. Dorsal view.
3. *Lepus californicus bennettii* Gray. Adult male, No. 6868, Calif. Acad. Sci., from San Marcos, San Diego County, California. Dorsal view.
4. *Lepus californicus deserticola* Mearns. Adult male, No. 10682, Mus. Vert. Zool., from Needles, San Bernardino County, California. Dorsal view.



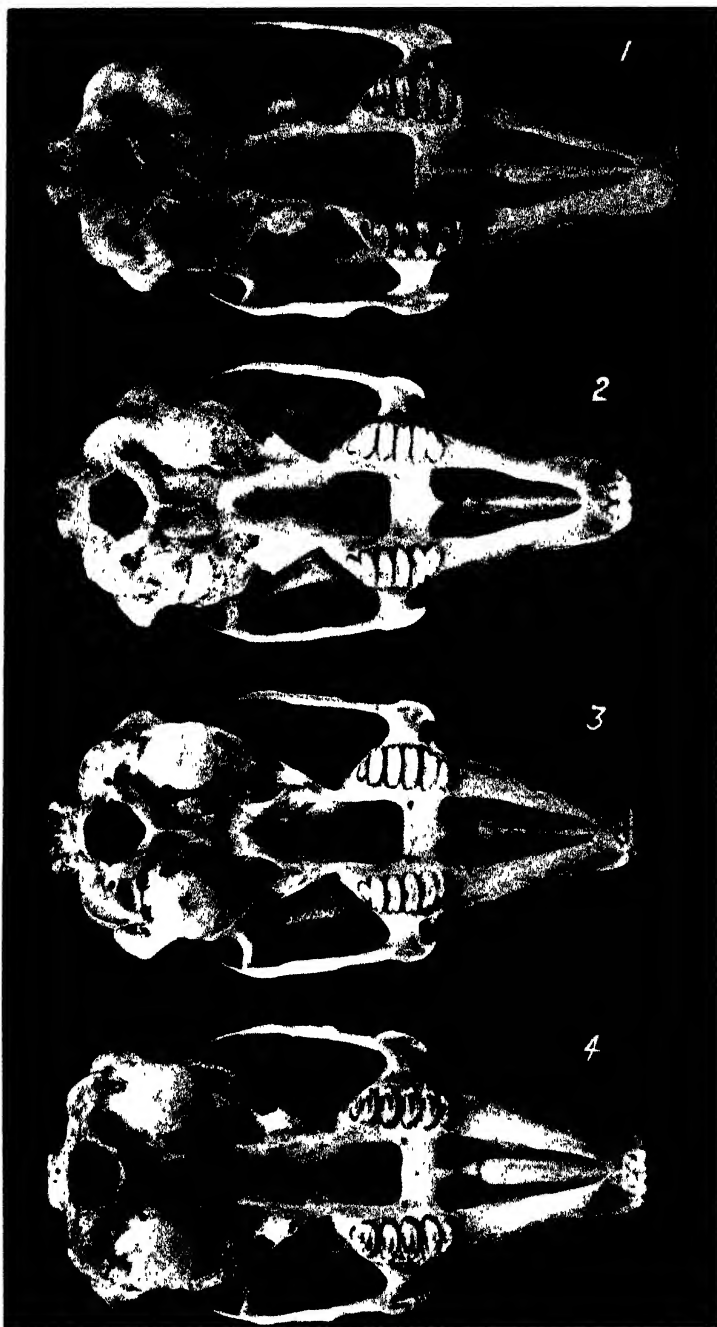


PLATE 4
(Natural size)

1. *Lepus californicus californicus* Gray. Adult male, No. 4811, Calif. Acad. Sci., from Red Bluff, Tehama County, California. Ventral view.

2. *Lepus californicus richardsoni* Bachman. Adult male, No. 1028, Calif. Acad. Sci., from Buttonwillow, Kern County, California. Ventral view.

3. *Lepus californicus bennetti* Gray. Adult male, No. 6868, Calif. Acad. Sci., from San Marcos, San Diego County, California. Ventral view.

4. *Lepus californicus deserticola* Meains. Adult male, No. 10682, Mus. Vert. Zool., from Needles, San Bernardino County, California. Ventral view.

PLATE 5
(Natural size)

1, 2. *Sylvilagus nuttallii nuttallii* (Bachman). Adult male, No. 5073, Calif. Acad. Sci., from Eagleville, Modoc County, California. Dorsal and ventral views.

3, 4. *Sylvilagus nuttallii grangeri* (Allen). Adult male, No. 37233, Mus. Vert. Zool., from Austin, Lander County, Nevada. Dorsal and ventral views.



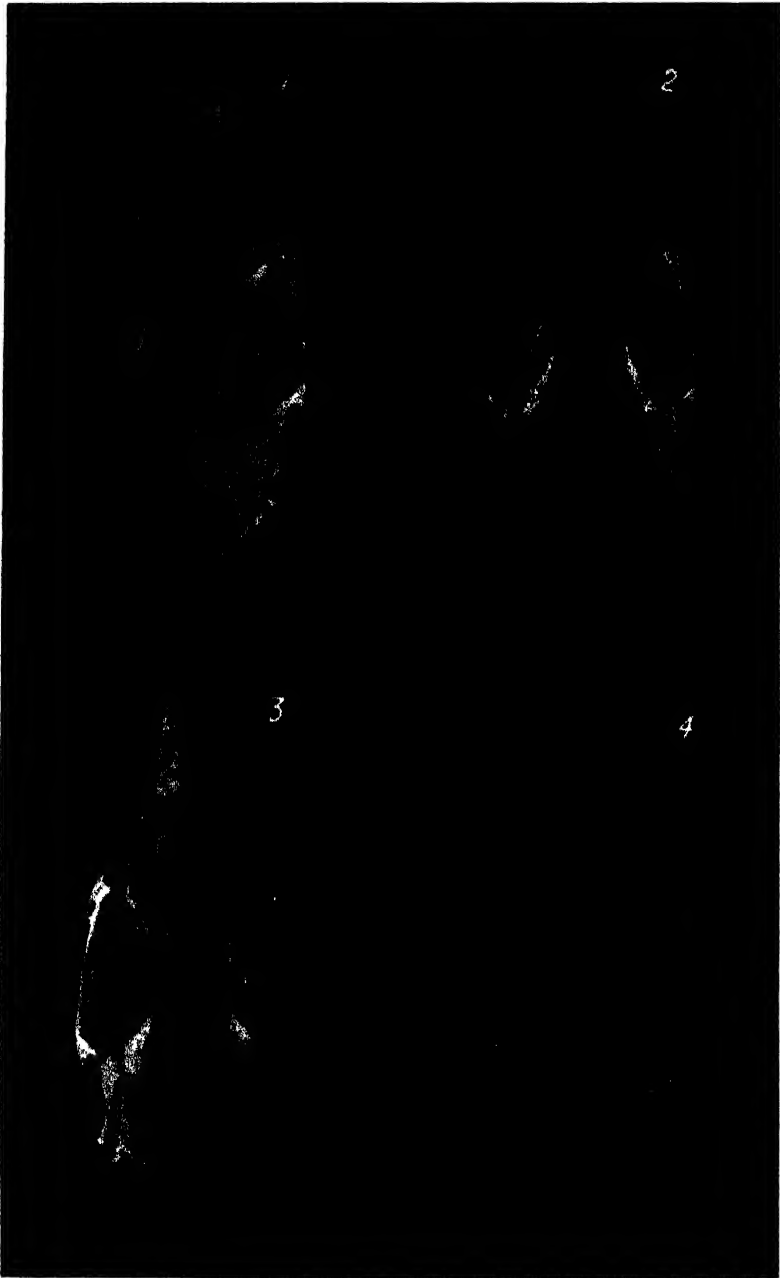
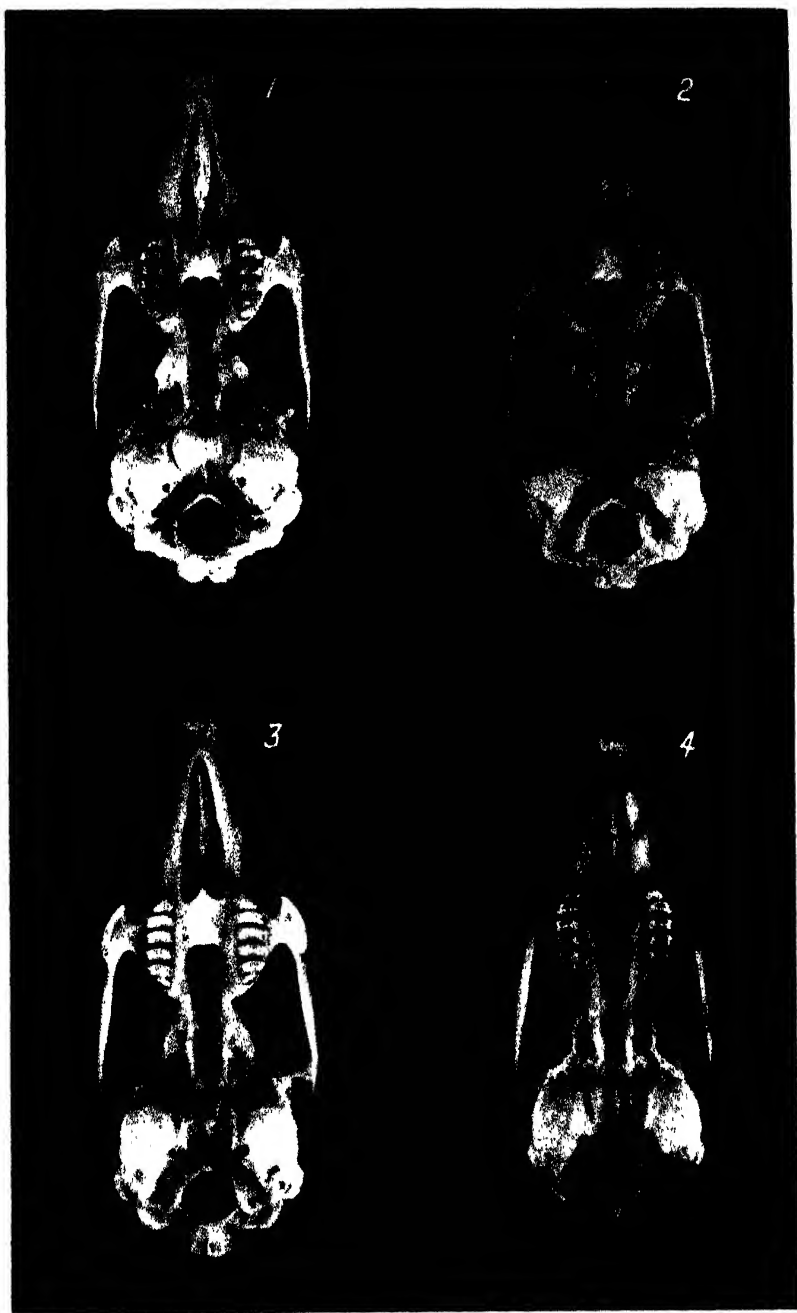


PLATE 6
(Natural size)

1. *Sylvilagus auduboni auduboni* (Baird). Adult male, No. 59914, Mus. Vert. Zool., from near Chico, Butte County, California. Dorsal view.
2. *Sylvilagus auduboni vallicola* Nelson. Adult male, No. 990, Calif. Acad. Sci., from Buttonwillow, Kern County, California. Dorsal view.
3. *Sylvilagus auduboni sanctidiegi* Miller. Adult male, No. 6873, Calif. Acad. Sci., from Marcos, San Diego County, California. Dorsal view.
4. *Sylvilagus auduboni arizonae* Allen. Adult male, No. 61909, Mus. Vert. Zool., from Colorado River, 14 miles east of Searchlight, Clark County, Nevada. Dorsal view.

PLATE 7
(Natural size)

1. *Sylvilagus audubonii audubonii* (Baird). Adult male, No. 59914, Mus. Vert. Zool., from near Chico, Butte County, California. Ventral view.
2. *Sylvilagus audubonii vallicola* Nelson. Adult male, No. 990, Calif. Acad. Sci., from Buttonwillow, Kern County, California. Ventral view.
3. *Sylvilagus audubonii sanctidiegi* Miller. Adult male, No. 6873, Calif. Acad. Sci., from San Marcos, San Diego County, California. Ventral view.
4. *Sylvilagus audubonii arizonæ* Allen. Adult male, No. 61909, Mus. Vert. Zool., from Colorado River, 14 miles east of Searchlight, Clark County, Nevada. Ventral view.



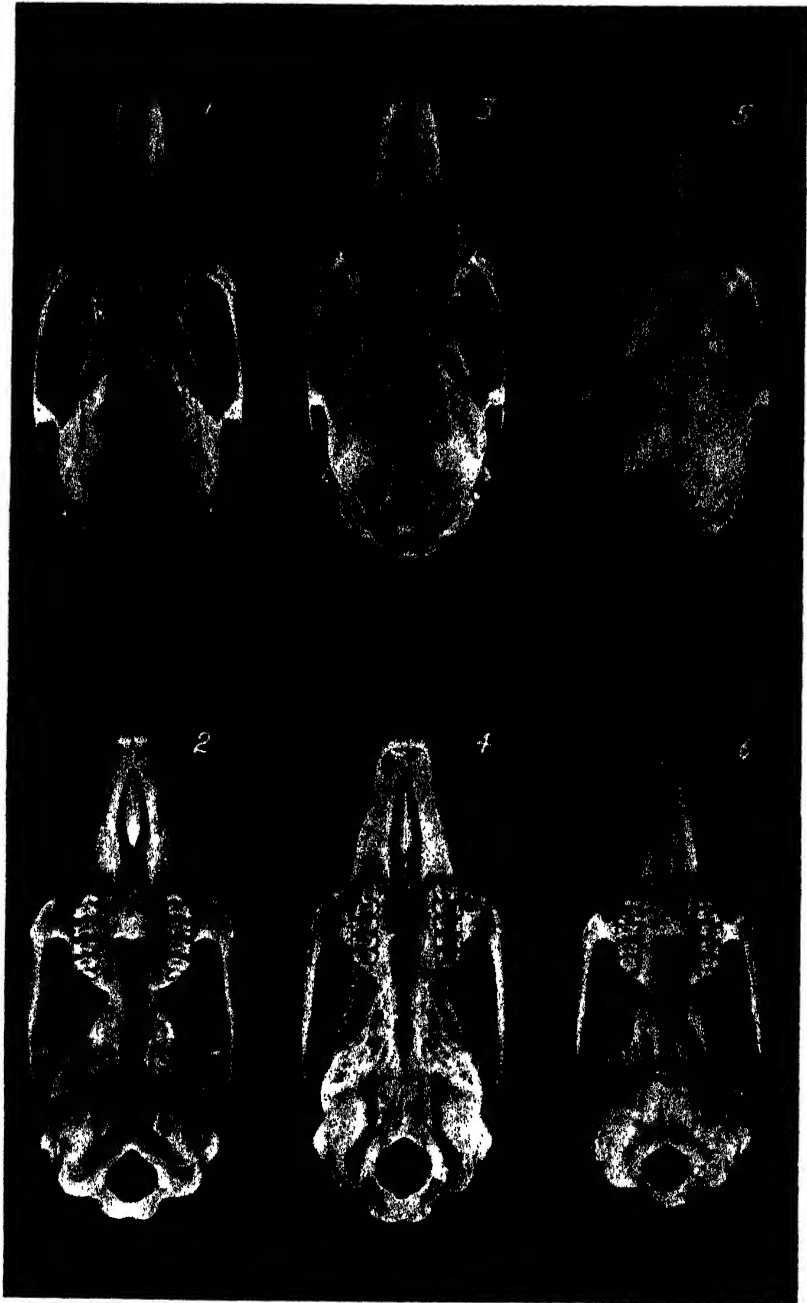


PLATE 8
(Natural size)

1, 2. *Sylvilagus bachmani ubericolor* (Miller). Adult male, No. 3888, Calif. Acad. Sci., from Requa, Del Norte County, California. Dorsal and ventral views.

3, 4. *Sylvilagus bachmani tehamae* Orr. Adult male, No. 36932, Mus. Vert. Zool., from Manton, Tehama County, California. Dorsal and ventral views.

5, 6. *Sylvilagus bachmani mariposa* Grinnell and Storer. Adult male, No. 23620, Mus. Vert. Zool., from Yaram, Mariposa County, California. Dorsal and ventral views.

PLATE 9
(Natural size)

1, 2. *Sylvilagus bachmani riparius* Orr. Adult male, No. 55133, Mus. Vert. Zool., from near Vernalis, Stanislaus County, California. Dorsal and ventral views.

3, 4. *Sylvilagus bachmani macrorhinus* Orr. Adult male, No. 63393, Mus. Vert. Zool., from near Portola, San Mateo County, California. Dorsal and ventral views.

5, 6. *Sylvilagus bachmani bachmani* (Waterhouse). Adult male, No. 357, Calif. Acad. Sci., from Monterey, Monterey County, California. Dorsal and ventral views.

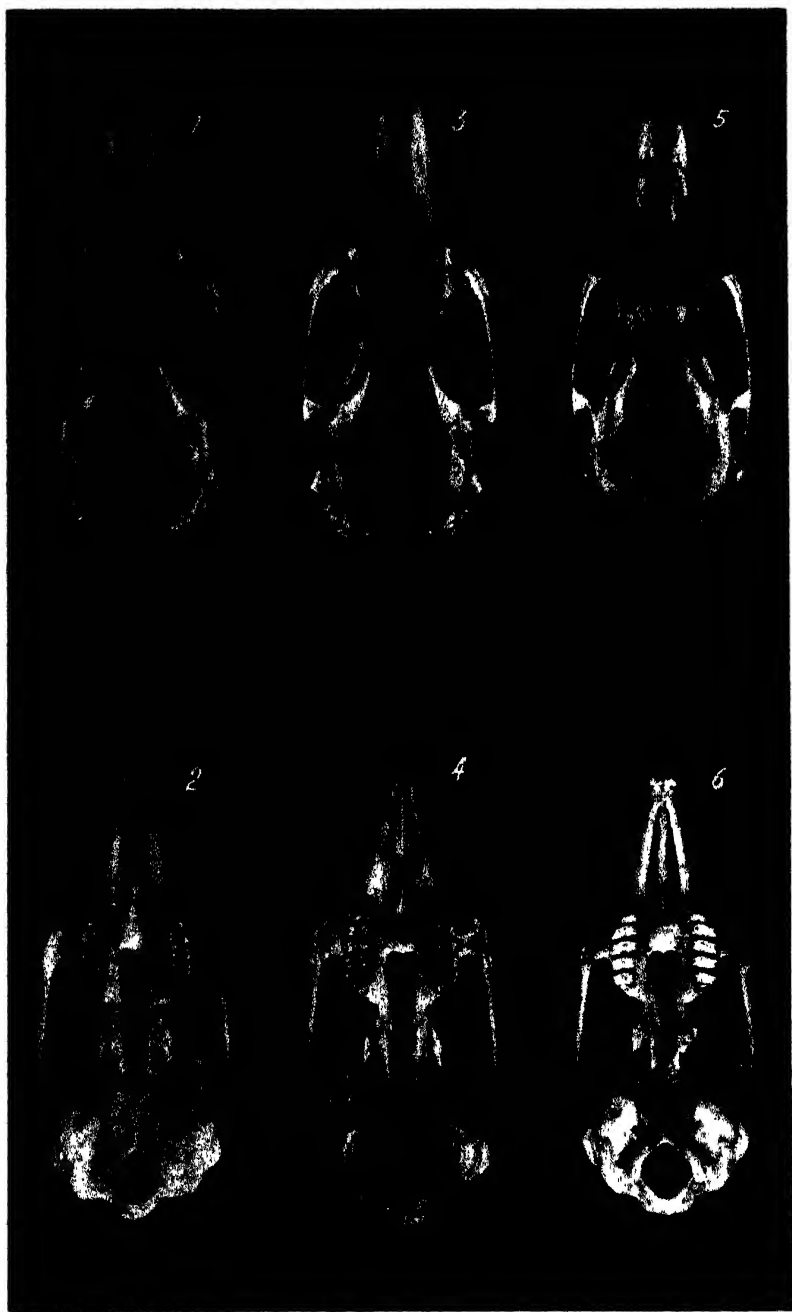




PLATE 10
(Natural size)

1, 2. *Sylvilagus bachmani virgulti* Dice. Adult male, No. 55128, Mus. Vert. Zool., from Waltham Creek, southeast of Priest Valley, Fresno County, California. Dorsal and ventral views.

3, 4. *Sylvilagus bachmani cinerascens* (Allen). Adult male, No. 3679, Mus. Vert. Zool., from Escondido, San Diego County, California. Dorsal and ventral views.

5, 6. *Sylvilagus idahoensis* (Miller). Adult male, No. 36358, Mus. Vert. Zool., from near Ravendale, Lassen County, California. Dorsal and ventral views.

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